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CONSTRUCTION OF NORRIS DAM CONTINUES NIGHT AND DAY
Tennessee Valley Authority Project on the Clinch River, Tennessee

Volume 5 — Number 4 —

APRIL 1935

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Controlling the Tennessee River

TVA Projects for Navigation, Flood Control, and Power Involve Several Dams, Three of Which Are Under Construction

ATTENTION was once more focused on the Tennessee Valley when in April 1933 Congress passed the Norris Bill, creating the Tennessee Valley Authority and specifically directing the construction of a dam on the Clinch River, one of the largest tributaries of the Tennessee. Charged with the large-scale production of hydro-electric power, improvement of navigation, control of floods, and the betterment of agricultural, industrial, and social conditions in the valley, the Authority immediately began construction of the 250-ft Norris Dam on the Clinch River.

On the Tennessee River itself, 250 miles by river below the Norris Dam, is the Wilson Dam at the foot of Muscle Shoals—a wartime project built by the Government to develop power for the manufacture of nitrates—which now raises the river level about 90 ft and backs it up for about 18 miles. At the headwaters of Wilson Lake, the Authority has the Wheeler Dam under construction. This will raise the river a height of 50 ft and back it up for 80 miles. About 50 miles below the Wilson Dam is the Pickwick Dam, on which construction has been started by the Authority. This structure will raise the river about 60 ft and back it up to the foot of the Wilson Dam. When completed, these dams will provide slack-water navigation for 150 miles. The power generated by their run-of-the-river hydro-electric installations will be materially augmented by the release of flood water stored in the Norris Reservoir.

The three articles that follow are abstracts of papers presented before the joint session of the Society's Power Division and the Hydraulics Division of the American Society of Mechanical Engineers on January 17, 1935, at the Annual Meeting of the Society in New York. The proposed uses of the three dams—Wilson, Wheeler, and Pickwick—are explained by Mr. Bowman; Mr. Hall describes the design and construction of the Wheeler Dam; and Mr. Jones the plans, foundation, and construction of the gravity-type Norris Dam.

A Complicated Problem of Regulation

By JAMES S. BOWMAN
MEMBER AMERICAN SOCIETY OF CIVIL ENGINEERS
PRINCIPAL HYDRAULIC ENGINEER, TENNESSEE VALLEY AUTHORITY, KNOXVILLE, TENN.

FOR almost a century, the possibility of using the Tennessee and its tributaries for navigation and power has been repeatedly investigated. The projects proposed and constructed from time to time indicate the vital interest in these two uses of the river, and always the need of regulation to increase low-water flow and to reduce flood heights has been outstanding. Heretofore this need has never been met for the following reasons:

1. Major flood-control problems were not recognized as a matter of national policy.
2. It was difficult to coordinate all these aims under any existing agency.
3. The resources of existing agencies were meager; not only were their funds inadequate but such funds as they had could not be allocated for the purpose.

CHARACTERISTICS OF THE BASIN

A consideration of the basin as a whole is important for an understanding of the individual projects. Above its confluence with the Ohio at Paducah, Ky., the Tennessee River drains an area of 40,600 sq miles. Its length to the junction of the French Broad and Holston rivers above Knoxville is 652 miles, and thence to the headwaters of the Holston, in southwestern Virginia, the distance is 220 miles more.

Roughly the drainage basin (Fig. 1) may be visualized as a huge crescent facing northward, with one point at Paducah and the other at Tazewell, Va. At Chattanooga, near the center of the crescent, its average width of 110 miles is reduced to 40 miles by a constriction 50 miles long. The eastern half lies in a broken and mountainous region of high precipitation and steep slopes; whereas the western half has low relief with flat gradients, except at Muscle Shoals, and the tributaries there are long and sluggish.

This difference between the two parts of the basin rather definitely determines the plan for utilization and control. Below Chattanooga there is no opportunity for high-head developments on the main river,

or a large amount of storage on the tributaries. In this stretch plants for the combined uses of power, flood control, and slack-water navigation are possible. In the upper part of the pools there will be considerable reserve storage for low-flow regulation and to reduce flood peaks. Above Chattanooga, with the exception of the main river and the lower sections of the principal tributaries, there are a number of sites for storage dams and high-head developments. Here it is possible to provide regulation of flow for flood control and power as well as for navigation on the main river until such time as slack-water navigation is completely developed.

FIG. 1. DRAINAGE AREA OF TENNESSEE RIVER AND LOCATION OF EXISTING AND PROPOSED DAMS

There are possibilities for the ultimate control by storage of the run-off from about 17,000 sq miles, or 40 per cent of the drainage area. Of this total, 15,000 sq miles lie above Chattanooga. It remains to be determined whether regulation to this extent is economical.

HYDROLOGY OF THE BASIN

Precipitation in the Tennessee River basin varies on account of differences in elevation, the shielding effect of mountain ranges, and the passing of different storm tracks over the east and west parts. It ranges from an annual average maximum of 75 in. in the Appalachians to that of 50 in. in the lower valley. The mean annual precipitation for the entire valley is about 52 in., and the average annual loss from evaporation, transpiration, and deep seepage is about 28 in. The run-off characteristics of the Tennessee River and its principal tributaries are given in Table I. Some inconsistency may be expected in the values there listed on account of the varying length of the records. The major floods may occur from January to April, but the greater number come late in March or early in April. Normally, the depletion period begins in the middle of July and continues, with little replenishment, until early in December. The lowest water is in October or November.

TABLE I. RUN-OFF OF TENNESSEE RIVER AND PRINCIPAL TRIBUTARIES

River	Station	Drainage Area in Sq Miles	Run-Off in Cu Ft per Sec per Sq Mile		
			Max.	Min.	Mean
Tennessee	Mouth	40,600	..	0.12	1.63
Tennessee	Florence	30,800	14.5	0.14	1.72
Tennessee	Chattanooga	21,400	16.9	0.15	1.77
Tennessee	Knoxville	8,990	21.8	0.16	1.54
Duck	Centerville	2,070	21.2	0.04	1.48
Elk	Elkmont	1,700	30.4	0.05	1.75
Hiwassee	Reliance	1,220	46.0	0.31	2.20
Ocoee	Emf	530	40.5	0.22	2.44
Clinch	Clinton	3,090	24.3	0.07	1.51
Powell	Arthur	685	40.5	0.12	1.99
Little Tennessee	McGhee	2,450	47.5	0.19	2.52
French Broad	Dandridge	4,450	..	0.08	1.60
Holston	Rogersville	2,060	34.4	0.17	1.41

COMPROMISE OF CONFLICTING PURPOSES

In general the problem of regulation for flood control, navigation, and power involves conflicts of interest that cannot be completely reconciled. In a particular instance this simply means compromise to serve the most dominant interest or to afford the greatest general benefit in the most economic manner.

Under the proposed plan, improvement of the main river will consist mainly of dams averaging somewhat over 50 ft in height for slack-water navigation, flood control, and power development. On the tributaries, dams will be provided to supply the maximum amount of economical storage. These will regulate the flow of the Tennessee for the dual purpose of power generation and flood control. Slack-water navigation will be secured on the lower reaches of the tributaries to such an extent as may be justified. After the project for slack-water navigation has been completed, regulation for open-channel improvement will of course cease to be a factor. However, regulation by storage will still have a significant effect on low-water and flood stages in the lower Ohio and Mississippi.

To the extent that flood waters can be stored for low-flow regulation, these purposes are not in conflict. But however well this may be done under average conditions, at critical times the same storage capacity cannot be used for both purposes without curtailing one function or the other. Between the time that the floods cease and the depletion period begins, the run-off is insufficient to fill any considerable part of the storage that might be reserved for low-flow river regulation. Hence flood control in this region must be accomplished at least in part by storage provided for that purpose alone, in addition to that required to equalize flow in the low-water season.

On a river having the characteristics of the Tennessee, complete regulation is both uneconomical and unnecessary for any purpose. Since the generating plants at the reservoirs will be largely idle while water is being stored, the flow at main river plants from the uncontrolled area during this period must be sufficient to generate the same amount of power as is furnished by the entire system when the stored water is being withdrawn. This implies power installations at the upper storage reservoirs; these are justified by the fact that high heads can be secured at most of the sites. The storage required to give various firm flows at Florence, Ala., is indicated in Fig. 2.

As the storage is progressively increased by additional construction for supplementing low stages of the river, more and more of the flow from unregulated areas is converted to firm flow for the generation of primary power. Consequently less and less water can be stored without reducing the flow already utilizable at plants on the main river. The regulated flow equivalent of power produced at storage developments during the low-water season will be additional to this. For instance, the minimum power generated at the Norris Dam during the dry season would be equivalent to a flow of 7,000 cu ft per sec at the Wheeler and Wilson dams and to this extent would fill in the valleys of the power-hydrograph for the lower river. In this respect the Tennessee, with its many possible storage sites on the headwaters, and its long main river providing additional sites for low-head development but with less storage, differs from many of the major rivers of the country.

Flood peaks move down the main river slowly because of its comparatively low gradient. In floods resulting from general precipitation, as many as three distinct peaks produced by concentrated flows from certain tributaries may pass down the middle and lower river before the peak from the upper end of the river itself arrives. The effect of the constriction in the watershed near Chattanooga is very noticeable. In this area the immediate inflow is small as compared with the size and length of the channel. Accordingly, in major floods the highest peak on the lower river passes downstream from the mouth of the Elk River before the section between Decatur and Chattanooga is in flood. The peak from the upper river reaches Chattanooga about two days later, arrives at Decatur on the third day, and is often not as high on the lower river as the first peak.

This phenomenon has considerable bearing on the extent of floods and the methods needed for their control. In the Tennessee Valley, flood damage is caused by high peaks of comparatively short duration. Flood control can be accomplished by reducing or obliterating these peaks. The danger of a cumulative peak caused by a too prolonged release of flood water must be avoided by permitting the floods from the lower tributaries to pass down the river as rapidly as possible.

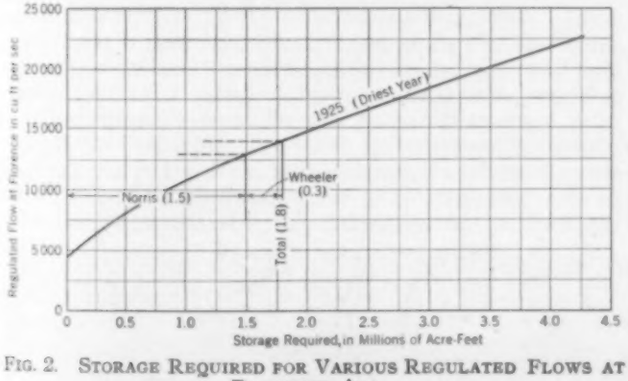


FIG. 2. STORAGE REQUIRED FOR VARIOUS REGULATED FLOWS AT FLORENCE, ALA.

At present there are only two seasonal storage reservoirs of any great magnitude in the Tennessee Valley: Santeetlah Reservoir of the Aluminum Company of America, on the Cheoah River, a tributary of the Little Tennessee; and the Blue Ridge Reservoir of the Tennessee Electric Power Company, on the Toccoa River, a tributary of the Hiwassee. Their combined effective storage is 280,000 acre-ft. Both are operated to regulate flow for the generation of power, but incidentally they furnish some regulation for navigation, and for flood control to the extent of the unfilled power storage. The drainage area tributary to both totals only 407 sq miles. During the low season they may contribute an additional flow of approximately 900 cu ft per sec to the river, depending on the method of operation.

FUNCTIONS OF NORRIS DAM

Three dams—Norris, Wheeler, and Pickwick—are now under construction by the Tennessee Valley Authority. Norris Dam, on the Clinch River, will control

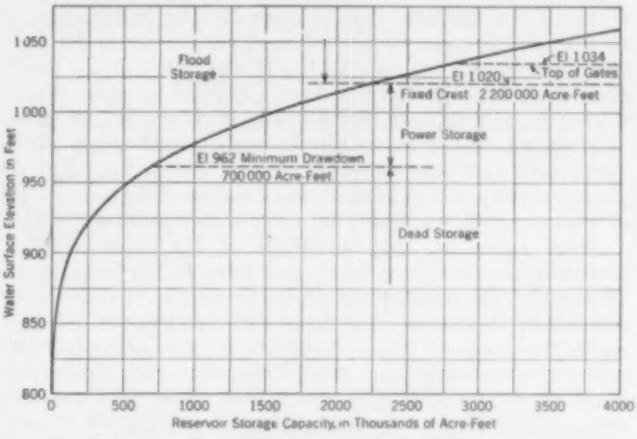


FIG. 3. CAPACITY CURVE FOR NORRIS RESERVOIR WITH CONTROLLING ELEVATIONS

a drainage area of 2,950 sq miles, or 7.26 per cent of the total area of the basin. In Fig. 3 is given the storage volume curve of the reservoir, together with the various storage levels.

The normal pool level and the maximum level for power storage will be at elevation 1,020, giving a gross head of 194 ft. With a maximum drawdown of 58 ft, 1,500,000 acre-ft will be available to regulate power output and navigation. This will mean an average contribution of 5,000 cu ft per sec to the low-water flow and an increase in the flow at Florence of from 10,000 to 16,000 cu ft per sec for 97 per cent of the time. With regulation by the Norris Dam, the extreme low flow will be about 12,900 cu ft per sec.

A tentative curve has been formulated to govern the use of storage in the Norris Reservoir so that the water will not be overdrawn in an extremely dry year, or in a succession of such years, making it necessary to resort to auxiliary power. As usual it has been found that it will be most economical, when the demand approaches the ultimate capacity of the system, to use the reservoir as much as possible each year, so that the normal storage capacity will be utilized in average years even though auxiliary power must be resorted to in dry years. The driest years experienced will determine the amount of auxiliary power capacity required to prime the system most economically for continuous output.

In practice the water that must be released from the Norris Dam will be calculated a week in advance from predictions as to flow and load requirements. As such forecasts will rarely be exact, the excess flow will be stored in the Wheeler pool or the deficiency made up from it. Any variations will be compensated for the following week.

At the Norris Dam provision will be made for normal storage of flood waters between elevations 1,020 and 1,044, or a volume of 1,000,000 acre-ft. While water is being stored between these elevations, the outflow

will be maintained as nearly uniform as possible, and will not be permitted to exceed 40,000 cu ft per sec, or bank-full stage in the Clinch River. Facilities for control at the Norris Dam consist of eight outlet conduits 5 ft 8 in. by 10 ft in section, controlled by sliding gates, and of three movable drum gates, 14 by 100 ft, on the crest of the spillway. The fixed crest will be at elevation 1,020, and the top of the drum gates, when raised, at elevation 1,034. During a flood, the pool can be maintained at elevation 1,020 until the outlets are all open and discharging 40,000 cu ft per sec. By passing the flow either over the top of the spillway gates or through the outlets, the outflow can be controlled so that it will not exceed 40,000 cu ft per sec until the pool has risen to elevation 1,044. If the flood is so great that the pool continues to rise, the level may be maintained at elevation 1,044 by lowering the drum gates as required, or the gates may be maintained at elevation 1,034 and the pool allowed to rise, depending on the probable duration of high rates of inflow and the amount of control made necessary by river stages downstream.

Final rules for the operation of the flood control facilities at this dam have not been fully developed. Obviously, the governing principle will be to allow its watershed to add as little as possible to the peak stages on the Tennessee River. Methods are now being worked out for predicting the stage, volume, and timing of flood peaks for the area above the dam and for the unregulated section at the mouth of the Clinch River. Forecasts will be based on special reports from river-gaging and precipitation stations in the area. While the storage possibilities at Norris will permit restriction of the outflow to 40,000 cu ft per sec for any probable flood, commencing with a reservoir elevation of 1,020, the rate and timing of release will be governed by the prospective volume of inflow and by the time that the crest of the flood on the Tennessee River will pass the mouth of the Clinch, so far as predictable.

Under the program of regulation here outlined, the greatest flood of record in 50 years would have filled the reservoir only to elevation 1,034—that is, to the crest of the drum gates when raised—and the outflow would not have exceeded 40,000 cu ft per sec. The maximum stage known in the past seems to indicate the possibility of a discharge of approximately 100,000 cu ft per sec.

EFFECT OF WHEELER RESERVOIR

Provision has been made at the Wheeler Dam for a drawdown of 5 ft below normal pool level on a reservoir area of about 67,000 acres, making 300,000 acre-ft of storage available on the lower river for equalizing releases from the Norris Dam, for regulation according to the weekly load factor, and for seasonal use in excessively dry years. With regulation at both Norris and Wheeler reservoirs, the firm flow at Florence will be about 14,000 cu ft per sec. The spillway crest gates consist of 60 Tainter gates 40 ft long, with a water face 14 ft deep.

The possibility of lowering the pool prior to the flood season, thus affording flood-peak storage, has been worked out. However, close coordination of operation is involved, especially if several pools in series are to be manipulated. Three fundamental principles are involved:

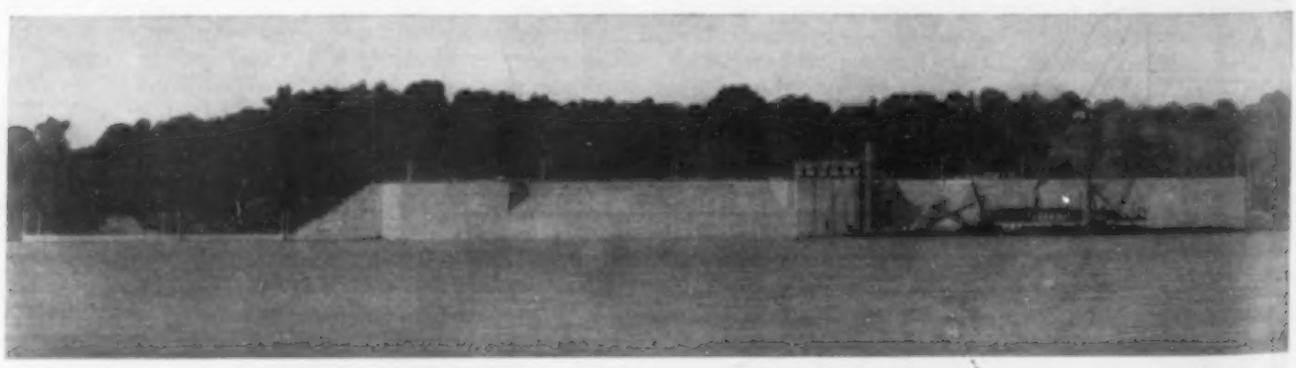
1. To lower the pools after it is known that a major flood is in prospect, or to maintain them abnormally low during the flood season.
2. To retain in the reservoir space thus provided a material volume from the peak of the flood.
3. To avoid synchronization of peaks at points downstream.

At the Wheeler Dam, a 3-ft rise above the normal elevation of headwater will be required to pass the maximum expected discharge. This will make available a considerable surcharge capacity for storage of flood peaks. The entire subject of movement of floods through the long pools of the main river plants on the Tennessee and of flood control by drawing on these pools and surcharging them is being studied. The theoretical approach is extremely involved and in practice many operating problems must be solved by very close control.

Wilson Dam at the foot of Muscle Shoals, near Florence, Ala., is a run-of-the-river development. It was completed in 1925. Although the gross head is 92 ft, the pool extends to the Wheeler Dam 18 miles upstream. It has a surface area of only 14,500 acres and provides very little storage for weekly regulation and none for flood control or seasonal use.

NEWLY AUTHORIZED STRUCTURE AT PICKWICK LANDING

Activities preliminary to construction are now under way for a project recently authorized at Pickwick Landing on the Tennessee River, 52.8 miles below the Wilson Dam. This development will consist of a concrete spillway section, earth embankment sections, a navigation lock 600 by 110 ft, and intakes for a future power house. The dam will provide a head of 61 ft at low water and create a pool having a surface area of 41,600 acres. At normal level, the pool will overlap the average tailwater elevation at Wilson Dam by several feet, eliminating most of the backwater effect and allowing sufficient drawdown to meet ordinary operating conditions without material loss of head between the two plants. The Pickwick Dam will provide such regulation as can be obtained during high or low river stages by the manipulation of the upper 5 ft of the pool, with the addition of a surcharge of 5 ft above normal pool



SINGLE-LIFT LOCK FOR WHEELER DAM CONSTRUCTED BY U. S. ARMY ENGINEERS
Lift 50 Ft, Chamber 60 by 360 Ft

level. As one of perhaps many projects that may be built for flood control on the tributaries of the Ohio and Mississippi, this dam will have a significant effect in the ultimate plan for the regulation of these rivers.

At low river stages, the release of water stored behind the Pickwick Dam will materially increase the navigable depth from Pickwick Landing to Paducah, until such time as slack-water navigation may be obtained on this reach of the river. Two of the major benefits that will result through the creation of slack water upstream to the Wilson Dam are:

1. Elimination of the Riverton Lock and Colbert Shoals Canal, which are now inadequate for barge traffic, and greatly increased depth of the Tuscumbia Bar and Sheffield Cut, where the existing minimum depths of 4 ft cannot be further increased by open-channel improvement.

2. Increase of the primary power at Wilson Dam, where operation on peaks in power demand at time of low flow is not now permissible, since it would render navigation impossible in the sections of river referred to.

In many ways the Tennessee Basin offers conditions as nearly ideal for the regulation of a large river as can be found. It is hoped that continued study and investigation of the hydraulics of the various projects, when completed, will determine the practical solution of some of the many broad problems of river regulation.

Design and Construction of Wheeler Dam

By WILFRED M. HALL

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ONE of the nation's great hydro-electric power sites is at the Muscle Shoals of the Tennessee River. From Brown's Island, a few miles west of Decatur, Ala., the Tennessee forms a series of rapids over what geologists term the Cincinnati anticline. The greatest fall in these rapids is 134 ft, extending over approximately 37 miles of river bed. Within this section, known as the Muscle Shoals, the principal drop is in the last 16 miles, where the river falls about 100 ft.

Muscle Shoals has played a prominent part in the history of the South for well over a century. In pioneer days, when inland rivers were the only practicable means of transportation in the wilderness west of the Alleghanies, settlers found the rapids a serious menace to communication.

Accordingly, in 1828 Congress allotted 400,000 acres of land in the Tennessee Valley to the State of Alabama, the sale of which should provide the funds necessary to build a canal around the shoals. Approximately $600,000 was raised in this way, and in 1831 work was started. Five years later the canal was completed, but almost immediately was found inadequate. Thereupon a railroad was built by private interests from Tuscumbia, at the foot of the shoals, to Decatur at the head. Cargoes taken off river craft at Tuscumbia were shipped by rail to Decatur, where they were again placed on river boats for shipment further up the Tennessee.

After the end of the Civil War the Government again took up the problem of navigation around the shoals. The Rivers and Harbors Act of 1871 contained a provision for another survey, as a consequence of which a second canal was authorized and construction begun in 1875. This canal, which required 15 years to complete, cost $3,200,000. Not only has it been expensive to maintain, but also in late years it has been inadequate for transportation.

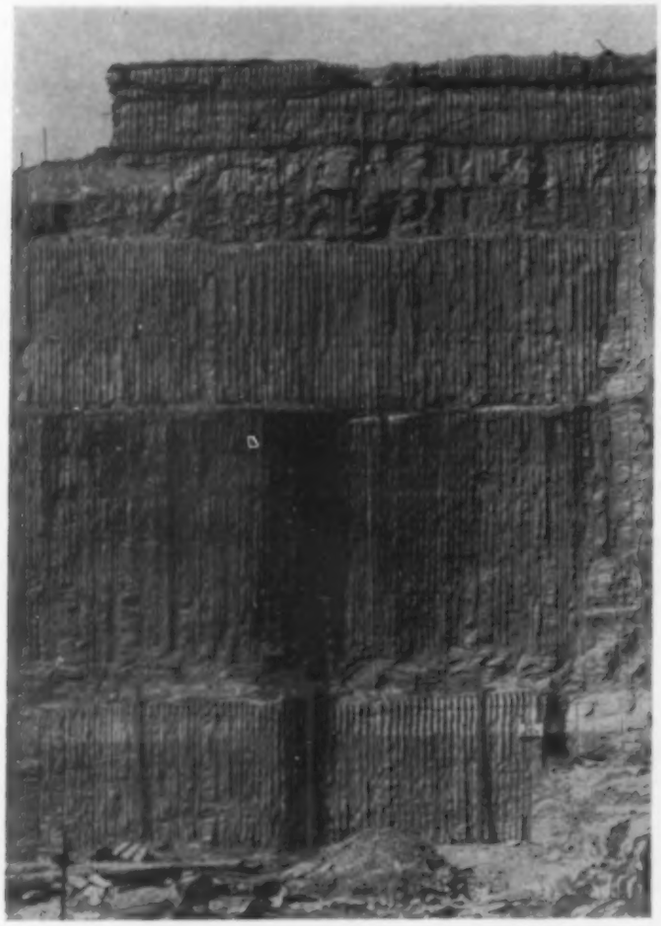
Wilson Dam, begun during the World War and finished shortly after, was built as an aid to navigation and at the same time to develop electric power for the fixation of nitrogen from the air for munitions. The pool behind the Wilson Dam covers but 16 miles of the lower section of the Muscle Shoals. Upstream from the head of Lake Wilson there are dangerous rapids, narrow channels around almost innumerable islands and partly submerged reefs, and other obstructions to navigation, which must be flooded in order to meet the needs of modern river transportation. A high dam built at the head of Lake Wilson would accomplish that end and at the same time provide for the generation of electric power.

In 1932 the War Department commenced the construction of a new navigation lock at the head of Lake Wilson and planned, on its completion, to build a dam. However, when the act creating the Tennessee Valley Authority (TVA) of 1933 was passed, the War Department abandoned these plans. In October 1933 the TVA was directed by the President to proceed with the construction of a dam at the head of Lake Wilson. This has been named the Wheeler Dam in honor of General Joe Wheeler, who fought in both the Civil and the Spanish-American wars and who made his home at Wheeler, Ala., about 17 miles from the dam site. The nearest railroad station is Town Creek, Ala., a village about ten miles to the southwest, but the site is connected with the surrounding towns by unimproved highways.

The Wheeler project will be a run-of-the-river development, designed to improve navigation and to generate power. The total reservoir capacity will be 1,085,000 acre-ft. With a 5-ft drawdown, the useful storage capacity amounts to 311,000 acre-ft, which will have the effect of increasing the continuous capacity at the dam between 12,000 and 24,000 kw, depending on the manner in which this storage is used in conjunction with that at Norris Dam. After both these dams are in operation, it is expected that the flow of the river can be maintained so that the available continuous hydro-electric capacity at Wilson Dam will be not less than 95,000 kw. At first this dam will have an installed capacity of 261,000 hp but there will be space in the power house for an ultimate installation of 612,000 hp. For continuous operation to ultimate capacity, the power plant at the Wheeler Dam, like that at the Wilson Dam, must depend on the release of stored waters from Norris and other dams to be constructed on the tributaries of the Tennessee River.

LOCK, DAM, AND POWER-HOUSE PROJECT

The Wheeler project consists of a single navigation lock, a gravity-type dam, and a power house. The over-all length of the structure will be about 6,400 ft, which is 1,900 ft longer than the Wilson Dam and 1,340 ft longer than the huge Dneiper River hydro-electric and navigation project in Russia. The dam will raise



EXCAVATION AT NORTH END OF POWER HOUSE
A Photographic Record Was Made of All Rock Faces Before Concrete Was Placed Against Them

the normal level of the upper end of Wilson Lake by 50 ft, forming a lake approximately 100 sq miles in area and extending up the river for more than 80 miles to Buck Island, 5 miles above Guntersville, Ala. The U. S. Bureau of Reclamation is preparing the designs for the dam and power house, subject to the approval of the Tennessee Valley Authority (Figs. 1 and 2).

Construction work commenced on the navigation lock in December 1932. The original plans provided for a 60 by 360-ft lock with a 37-ft lift, but the Tennessee Valley Authority arranged to have the lift increased to 50 ft. On completion, this lock will be one of the highest single lifts in the United States. It was well under way when construction on the dam was commenced in November 1933. The wall on the land side of the lock is about 200 ft from the north bank of the river to leave room for a second and larger lock, 110 by 600 ft in size, which may be constructed at some future date. For the present a section of non-overflow dam connects the lock with the cliffs of the north abutment.

Beginning at the south bank, the structure is made up successively of a non-overflow section 180 ft long, a power house 613 ft long, a second non-overflow section 667 ft long, a spillway 2,700 ft long, a third non-overflow section 1,712 ft long, a lock 159 ft wide, and a fourth non-overflow section 270 ft long, which ties the structure into the north bank. In addition there is one 45-ft trashway section immediately north of the power house, and a similar one immediately south of the lock.

The main non-overflow section, resting on tight ledge rock at an average depth of 10 ft below the river bed, is 55 ft wide at the base and 70 ft high. An inspection gallery 6 ft wide by 8 ft high, with an arched roof, extends throughout the length of the dam. Including the apron, the spillway section will be 124 ft wide. The toe of the apron, the deepest part, is approximately 24 ft below the river bed. Concrete energy dissipaters are to be built on top of this toe to retard the passage of water into the pool. The gravity section of the spillway is 54 ft high. End training walls, 5 ft thick, will rise 12 ft above the pool, while 10 intermediate training walls will just reach the water surface below the dam. The spillway is divided into 60 bays, each of which will be surmounted by a radial gate 14 ft high and 40 ft long. Each gate can discharge water at the rate of 8,000 cu ft per sec without raising the level of the Wheeler pool.

Reinforced concrete piers on top of both non-overflow and spillway sections will support a 20-ft roadway. As the roadway approaches the lock from the south side, it will have a rising grade in order to obtain a clearance of 57 ft over the upper pool level where it crosses the lock. This will permit uninterrupted flow of highway traffic across the dam without interfering with the passage of boats through the lock.

Initial construction in the power house will consist of eight forebays, complete with the necessary trash racks and emergency and service slide gates. Eight draft-tube sections are being excavated, at the deepest point

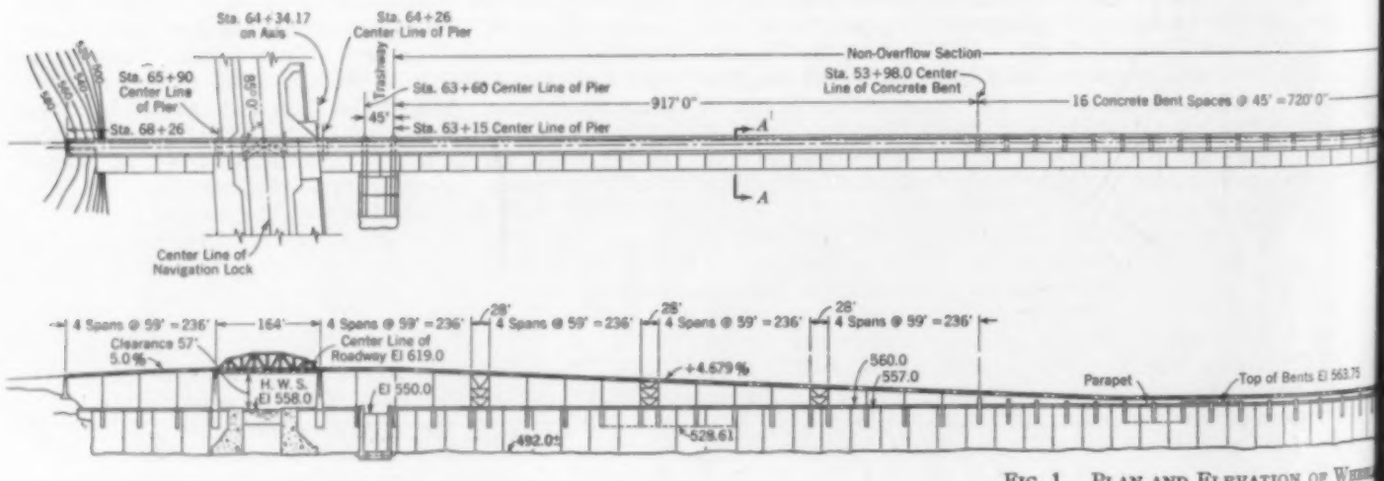


FIG. 1. PLAN AND ELEVATION OF WIL
Structure More Than a Mile L

to 55 ft below the bed of the river. Pumps and piping will be installed so that the draft tubes may be individually or collectively unwatered when the additional units are erected. Foundations for two units will be completely constructed at this time, but only one complete generating unit, with the necessary auxiliaries, will be installed.

Of the outdoor type, the Wheeler power house will have no housing over the cranes, and the generators will be protected from the weather by removable metal covers. The turbine operating floor, immediately above the turbine casings, will contain the governors, actuators, governor oil pumps, lubricating oil pumps, and other auxiliary equipment. The control room, containing the main switchboard, will be at the south end of the power house. Also in this area will be the machine shop, the switching equipment for use in the power house, the storage batteries, oil storage and purifying equipment, as well as work space for the overhauling of various parts of the generators, turbines, and auxiliary equipment. An entrance for a railroad track will be provided at the elevation of the machine shop floor so that apparatus can be moved directly into the power house on railroad cars.

A trash-rack structure will be built on the upstream face of the power house to protect the entrances to the penstocks, and the racks will be cleaned by a mechanical rake. For the handling of trash racks, gates, and trash raking equipment, an 85-ton gantry crane will be installed on a track extending the entire length of the forebay structure.

The turbines, only one of which will be included in the initial installation, will be of the vertical-shaft type with a concrete spiral scroll case and fixed-blade propellers. Each turbine will have a rating of 45,000 hp at an effective head of 48 ft net. Provision will be made for admitting compressed air to the turbines so that the generators can be operated as synchronous condensers for the regulation of voltage on the transmission lines.

Each turbine will have a governor of the actuator type with motor-driven speed-responsive element. Each governor will have its own oil-pressure system, including motor-driven pump, pressure tank, and sump tank. The pressure system of each two adjacent governors will be interconnected so as to provide a stand-by source of oil pressure for each system. Each main generator will be 3-phase, 60-cycle, 13,800-v and 36,000-kva, and will have a direct-connected main exciter and pilot exciter. Quick-response excitation will be provided to stabilize the load on the transmission line. Fire extinguishing equipment of the automatic carbon dioxide type will be provided for each generator, which will also have an automatic voltage regulator of the non-vibrating type, designed for use with high-speed response excitation.

A bank of step-up transformers will be installed for each pair of main generating units. Each bank of transformers will consist of three 24,000-kva, 60-cycle,

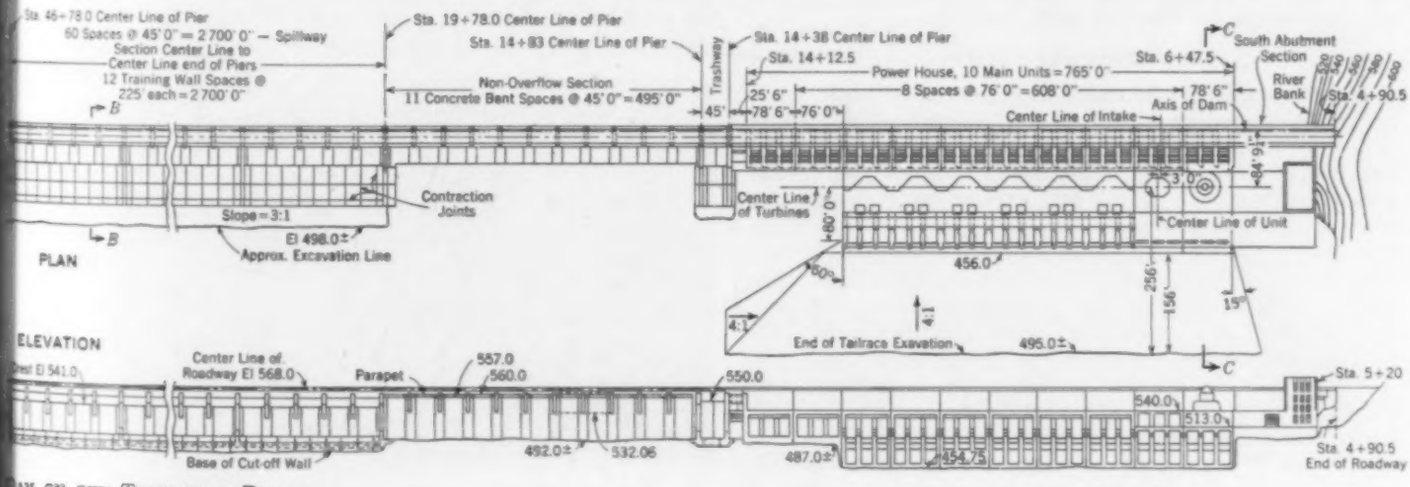
GENERAL VIEW OF CONSTRUCTION COFFERDAMS
On the Opposite Shore the Navigation Lock Appears

single-phase, 15,200/154,000, Y-connected, outdoor, oil-insulated, self-cooled transformers.

In addition to the gantry crane provided over the trash-rack structure, there will be another such crane of 250-ton capacity over the power house. This will be used to move the parts of the main units. A small crane of about 10-ton capacity will be installed in the machine shop area and will be so located as to be available for unloading materials direct from railroad cars. The large gantry will cover this same area.

GEOLOGIC CONDITIONS REQUIRE CAREFUL STUDY

The foundation of Wheeler Dam is made up of a series of sedimentary beds lying nearly horizontal. They consist chiefly of cherty and siliceous rock, of a more massive type than the usual shale, alternating with layers of a very fossiliferous and almost pure limestone. In this series the shale beds are much thicker than the limestone ones, and alternate with them. On the north side of the river the dip is slightly downstream, but on the south side it is slightly upstream. It would appear that in the uncovered ground toward the center of the



DAM ON THE TENNESSEE RIVER
Will Raise the Water Level 50 Ft

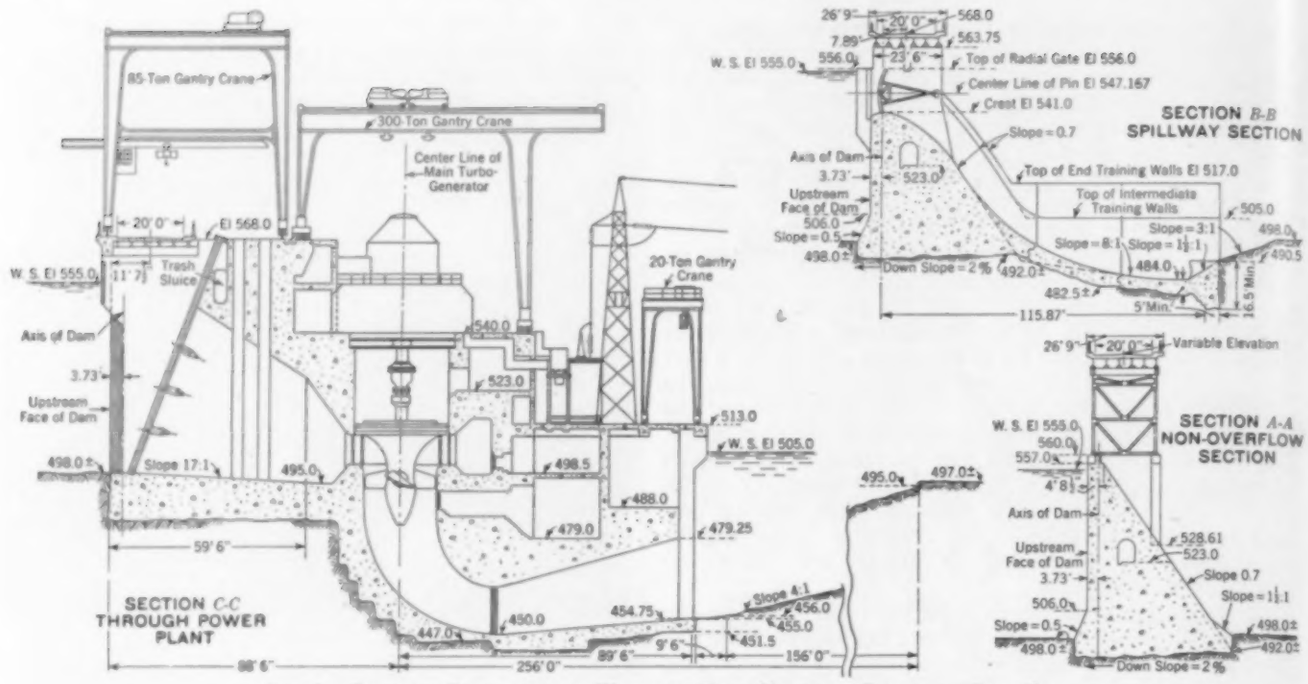


FIG. 2. SECTIONS THROUGH THE WHEELER DAM (SECTIONS REFER TO FIG. 1)

river the dip may be reversed more than once. These changes in dip indicate slight deformation or warping, in the course of which joints have been developed across the strata, some confined to individual beds that are comparatively brittle but others, which may be referred to as master joints, passing through the whole succession of beds from top to bottom. Although cavernous formations have been found at numerous places, all the caverns have been very small with the exception of two in the foundation for the draft tubes. The foundation proper is not materially weakened by the small solution channels found. These are bridged over by sound rock, and the load placed on the foundation will not be sufficiently great to break in their roofs. To prevent future action and circulation of water along these channels, they have been blocked off at the upper end or throughout by concrete cut-off walls, or by careful grouting. In the abutments special treatment is being applied. The limestone beds will be followed with tunnels or cut-off trenches extending along the axis of the dam to discover where caverns cross this line and thus offer possibilities of leakage. Whatever caverns are found will be blocked with concrete.

FOUNDATION EXPLORATION

Investigations of the foundation for the Wheeler Dam had been carried on by the War Department at various times. They consisted chiefly of examination of a large number of cores from diamond-drill holes spaced on 100-ft centers both ways, and carried 34 ft below the river bed. They covered the entire area of the dam and lock. While the cores obtained indicated that sound rock existed throughout their depth, the holes were not deep enough in the power house area, and they did not show the location of bedding planes, shale and other seams, or the presence of solution caverns, if any.

Additional $4^1/_2$-in. shot-drill holes were put down in the draft tube area to explore the extent of the caverns found there. Sound rock was encountered at the bottom of the power house excavation, that is, at elevation 445, or 53 ft below the river bed, which is at elevation 498.

In the south abutment the rock formation showed the possibility of caves and open seams; hence holes having an average depth of 97 ft were drilled to elevation 473. In addition to the $4^1/_2$-in. core drill holes, three 36-in. holes were drilled in the spillway section in No. 2 cofferdam to elevation 479, which is the bottom of the keyway at the downstream end of the spillway apron. One 36-in. hole was also put down to elevation 473 in the main non-overflow section of the dam somewhat south of the spillway, and another one to elevation 471, somewhat south of the power house and about 26 ft downstream from the center line of the power units. Also, several of these holes are being drilled in and beyond the south abutment.

All the $4^1/_2$-in. cores were stored according to station numbers in order to form a profile of the rock formation in cofferdams Nos. 1 and 2. However, the 36-in. cores were not saved after examination, because they were made largely to investigate the walls of the holes. Although the $4^1/_2$-in. core borings indicated that no large cavities or open seams were present below the foundation of any part of the dam as far down as elevation 473, and although they gave a general idea as to how deep the foundations had to be carried to be below any open seams in the rock, they supplied no definite information

Concrete Materials and Mixing Equipment on Barges

PLACING CONCRETE

as to the location of bedding planes, their thickness, or tightness. An actual inspection of the sides of the holes could not be made either by periscope or by mirrors, as it was impossible to hold the water out long enough. The 36-in. core holes were, however, satisfactory in every way. They could be easily pumped out, and an observer could be lowered to the bottom to make a complete examination.

FOUNDATION TO BE GROUTED UNDER HIGH PRESSURE

All the foundations are being grouted under both low and high pressure, although only the low-pressure work has been done thus far. For low-pressure grouting, two lines of $2^1/_2$-in. grout holes are drilled with wagon drills on 20-ft centers, the holes being 20 ft deep and staggered. One of these lines is 1 ft upstream, and the other 19 ft downstream, from the axis of the dam. Before the grout is injected, each hole is given a hydrostatic test at 38 lb per sq in. After the test, a neat cement grout, composed of from $7^1/_2$ to $37^1/_2$ gal of water per sack of cement, is pumped in. The usual mix is 20 to 25 gal of water per sack, prepared in a paddle-type mixer driven by air motor. From the mixer the grout is discharged into a receiving hopper, which is equipped with a paddle-type agitator also operated by an air motor. The grout pump is of the duplex, plunger type and is air operated. During grouting the caps are removed from adjacent holes to relieve the air pressure and permit flow through any seams that may exist in the adjacent rock. This removal of caps is probably unnecessary, as only a very few holes show any indication of receiving grout from others. At the start of the grouting operation, a pressure of about 20 lb per sq in. was used. A check was maintained at the surface of the rock to determine whether there was any upheaval. Since no apparent movement was observed, the pressure was gradually increased to 40 lb per sq in. As the rock was taking a little grout at this pressure, near the completion of the grouting of each hole, the pressure was raised to 50 lb and held on the hole for at least 10 min. With few exceptions, all the holes took only enough grout to fill their volume alone. Apparently very little grout, if any, was forced into the underlying bedding planes.

High-pressure grouting will not be commenced until the concrete placed on bedrock has reached a depth of 10 ft. Wherever possible, drilling for such grouting has preceded the placing of concrete, and the grout pipes have been concreted in and extended to the upper face of the dam. In a few cases drilling has been done after the concrete has been placed. In this case drilling was done through vertical pipes, which were carried up with the concrete. High-pressure grout will be forced into the pipes at approximately 100 lb per sq in.

WATER SEALS PREVENT SEEPAGE THROUGH JOINTS

Seepage through the vertical contraction joints in the dam and power house is being prevented by a double seal in each joint. At both the upstream and downstream faces of the dam, 9 in. in from the surface, a strip of 20-gage, non-corrosive metal is being inserted. The over-all width of each strip is 9 in. and its center is at the joint. These strips, for which monel metal and stainless steel have been used, will extend from the rock foundation to the top of the dam. Before concrete is placed against a strip, it is coated with asphalt emulsion to a thickness of $^1/_{16}$ in. This is allowed to set before the concrete is placed.

In addition to the metal stops, an asphalt seal 8 in. in diameter is provided at each joint. This is located 3 ft from the upstream face only, and will extend from the rock foundation to the top of the dam. The form for each seal is set as each 5-ft lift of concrete is placed. After the forms are removed the recess is filled with hot asphalt. Two $^1/_2$-in. steam pipes placed in each recess, and joined at the bottom of the hole, are carried up lift by lift. On completion of the dam, live steam will be forced through them, melting the asphalt and causing it to fill all parts of the joints.

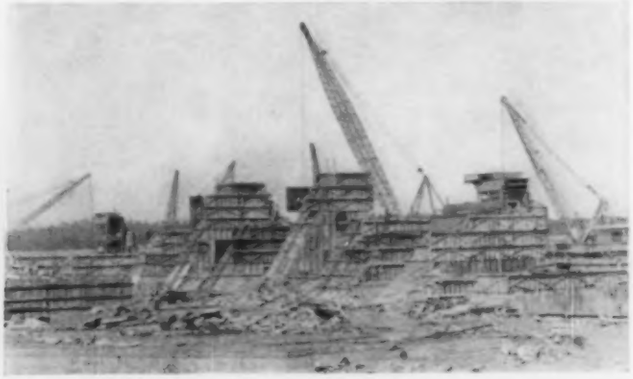
CONCRETE DESIGN AND CONTROL

The field laboratory has been equipped with all the necessary apparatus for testing concrete to keep control of proportions, use of cement, and strength. Cement tests are made in the Knoxville laboratory. The sand used is mostly of siliceous origin, and the coarser gravel is chiefly limestone. As for the aggregate, it is separated into four sizes at the dredge before delivery by barge to the mixing plants at the dam. These sizes are: sand, zero to No. 4; gravel, No. 4 to $^3/_4$ in.; $^3/_4$ to $1^1/_2$ in.; and $1^1/_2$ to 3 in. At the mixers the material is recombined in the proportions desired. The 3-in. gravel is used in the heavy unreinforced concrete and the smaller sizes in the reinforced parts of the dam and power house.

For Wheeler Dam the greater part of the concrete is designed to give a minimum strength of 3,000 lb per sq in. at 28 days. A water-cement ratio of 0.90 by volume is the maximum allowable.

A "modified" portland cement is being used for all the work. This cement, when incorporated in concrete, has a heat rise that is somewhat less than "normal," yet somewhat higher than that of the "low-heat" cement used at Boulder Dam. The cement is finely ground—

Pouring Foundation in an Unwatered Cofferdam
AT WHEELER DAM, ON THE TENNESSEE RIVER



Power House Section Under Construction

98 per cent passes a 200-mesh sieve—to offset any tendency toward a lowering of strength at 28 days due to the low heat of setting.

A river diversion plan, using five cofferdams, and adaptable to variations in construction schedule, has been decided upon. Beginning with the south cofferdam, which encloses the power house, the cofferdam lengths are: 1,425 ft, 1,238 ft, 1,147 ft, 1,100 ft, and 1,004 ft. It is the intention that only two adjacent cofferdams will be closed for any considerable time during each of the five stages. The spillway is enclosed by cofferdams Nos. 2, 3, and 4, and the main non-overflow section by Nos. 1, 4, and 5.

Except for that part of the non-overflow section in cofferdams Nos. 4 and 5, the dam will be built in alternate 15-ft and 30-ft blocks. As soon as the 30-ft blocks are placed up to elevation 506—that is, 1 ft above the Wilson pool—the 15-ft blocks will be built up above flood height. The cofferdam can then be removed and water diverted through the 30-ft openings. When the six intakes are completed, water may also be diverted through them. The intake floors are at elevation 498. At different stages of construction, flood water will be passed through various combinations of intakes, 30-ft diversion openings, and restricted river channel.

It is expected that the major part of the work of excavation and placing the concrete will be completed within the next 18 months, and that the entire undertaking will be entirely finished within the next two years. The magnitude of the project may be gaged from the following estimated quantities: rock excavation, 550,000 cu yd; concrete, 650,000 cu yd; reinforcing steel, 5,700 tons; structural steel, 3,000 tons; spillway gates, hoists, and appurtenant structures, 5,300 tons; turbine and governor, 2,600 tons; and generator and other equipment, 1,600 tons. In view of the considerable part of the construction period that still remains, there may be a number of changes in details. However, these should be of minor importance; the general arrangement will closely follow the plans already made.

Design of Norris Dam and Power House

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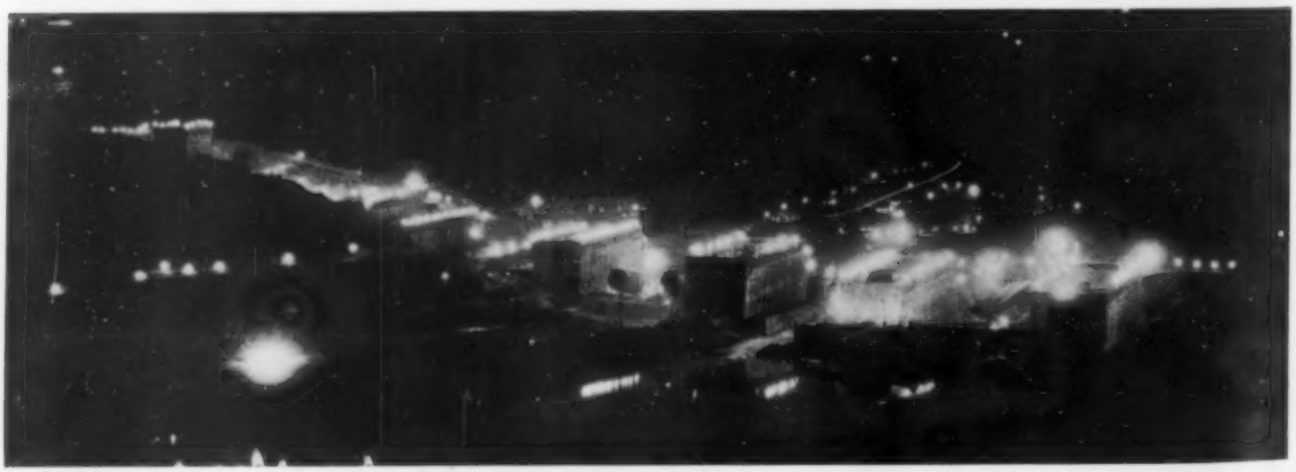
As early as 1911 the present site of the Norris Dam was investigated by power interests. In 1918 the Tennessee State Geological Survey issued a bulletin describing several dam sites, among them one on the Clinch River, approximately at the present location of the Norris Dam. Among the surveys by the U. S. Corps of Engineers authorized in 1923 by House Document No. 308, was a study of the Clinch and Powell rivers, the two most important tributaries of the Tennessee River, which join about 6 miles above the present site of the Norris Dam. Of the numerous possible dam sites found, that at Cove Creek was recommended.

Five possible locations were chosen for further consideration by the Corps of Engineers, three above the confluence of Cove Creek and the Clinch River and two below. Both navigation and flood control favored a site below the mouth of Cove Creek. In 1927 the Corps of Engineers resumed investigation of the site it had designated as "A," the present location of the dam. The Corps commenced final surveys preparatory to construction in April 1933, fifteen days before the passage of the Norris Bill creating the Tennessee Valley Authority. This bill specifically authorized construction of the Cove Creek Dam, now called the Norris Dam.

As soon as the act became operative, the Corps of Engineers passed on to the TVA all the accumulated data collected during the surveys, and the work started in April 1933 was taken over by the latter. The plans for the dam and power house were continued by the Corps of Engineers until completed in preliminary form, and on July 20, 1933, they also were transferred to the TVA. The U. S. Bureau of Reclamation, already under contract with the Authority for the design of the structure, proceeded at once to review the preliminary plans and to revise them in conformity with its experience and practice.

The short time available for preparing the design made it necessary to take up first only the major prob-



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THE NIGHT SHIFT AT NORRIS DAM

lems and to leave the details for consideration as construction progressed. The policy of building the dam with the Authority's own organization instead of by contract made it possible to commence construction before final detailed plans and specifications were completed. Aside from the benefit of an early start, this procedure resulted in noteworthy advantages through ability to adjust construction procedure and plans to the needs of the Authority, then in the formative stage, as well as to physical developments at the site. However, before work was commenced it was definitely determined that the sites of both reservoir and dam were satisfactory from the geological standpoint.

While flood control, navigation, and power are probably the most important uses for the Norris Dam and Reservoir, scenic and recreational values are also being recognized and developed as far as practicable. The reservoir will have an area of 37,500 acres and a shore line of about 664 miles during the summer months, when it will be full to the spillway level. The opportunities for boating, fishing, and residential use will add welcome recreational advantages to the region.

A comparison was made of four possible types of dam.

TUNNEL DRIVEN TO REMOVE A CLAY SEAM
Seam and Tunnel Were Later Filled with Concrete

Besides a power house and spillway for each type, these included a rolled earth-fill dam, two designs of rock fill, a concrete round-head buttress type, and a concrete straight gravity structure—the design finally chosen. As would be expected, the outstanding feature of these comparative estimates was the wide variation in the cost of the power plant for the two concrete types as compared with the higher costs for the two embankment types. A detailed investigation indicated that with the straight gravity type of dam (Figs. 1 and 2) the development would cost the least.

DESIGN OF DAM DEVELOPED

Studies were also made to determine the economic height for the dam, giving due consideration to the geology of the site and reservoir rim, as well as to the storage capacity needed for flood control and power production, and to the need for ample spillway and outlet capacities. In addition consideration was given to the effect of the dam on navigation and stream pollution, and on downstream developments, both present and future, along the Tennessee River.

Design of the dam cross section was based on an assumed hypothetical reservoir elevation of 1,052, which is 5 ft above the assumed maximum level and 8 ft below the top of the dam. With this condition of loading, the thickness of the cross section and the slopes of the upstream and downstream faces were proportioned so that the sliding factor, for a given assumption of uplift, would not exceed 0.65 in any part of the structure, except where it is reinforced against horizontal sliding, or shear, as in the case of the horizontal planes just below the drum-gate chambers in the spillway section. It was assumed that the maximum earthquake stress would occur when the reservoir was filled to the top of the drum gates in their raised position, at elevation 1,034; but this stress was not assumed to occur during the relatively short periods when great floods might fill the reservoir to the top of the dam, at elevation 1,060.

At elevation 800 the thickness at the base is 210.09 ft. As designed, the spillway section is 7 ft thicker than the non-overflow section at corresponding elevations below

FOUNDATION EXPOSED FOR LAST TWO BLOCKS IN SPILLWAY SECTION

the end of the crest curve. The maximum height of the dam will be 253 ft, and the total length of the concrete section will be 1,570 ft, including the spillway. Analyses of stress distribution, sliding factors, and factors of safety against failure in shear, for both spillway and non-overflow sections, were made for nine different assumed loads. No analyses of the effects of sand or silt loads on internal stresses were made, inasmuch as the accumulation of such deposits would simply mean a slightly increased vertical load on the face and no change in the unit horizontal pressure or the total horizontal force.

In the stress and stability analyses the unit weight of concrete was taken at 150 lb per cu ft (although the actual weight is 159 lb); the modulus of elasticity of concrete in compression and tension was taken at 4,000,000 lb per sq in.; the modulus of elasticity of concrete in shear, at 1,667,000 lb per sq in., reduced to 1,333,000 lb to allow for non-linear distribution of shearing stresses from the upstream to the downstream face; the modulus of elasticity of foundation and abutment rock in compression and tension, at 4,000,000 lb per sq in.; the coefficient of friction of concrete on rock, or concrete on concrete, at 0.65; and the ultimate strength of concrete in shear, at 400 lb per sq in.

The following assumptions were made in the analyses of stress and stability:

1. Vertical stresses vary as straight lines from the upstream to the downstream face of the dam at all elevations and at all locations in both spillway and abutment sections.
2. Stresses at the faces of the dam are acting in directions parallel to the slopes of the faces and are equal to the calculated vertical stresses divided by the squares of the cosines of the angles between the faces and the vertical directions.
3. Uplift pressures vary as a straight line from full reservoir

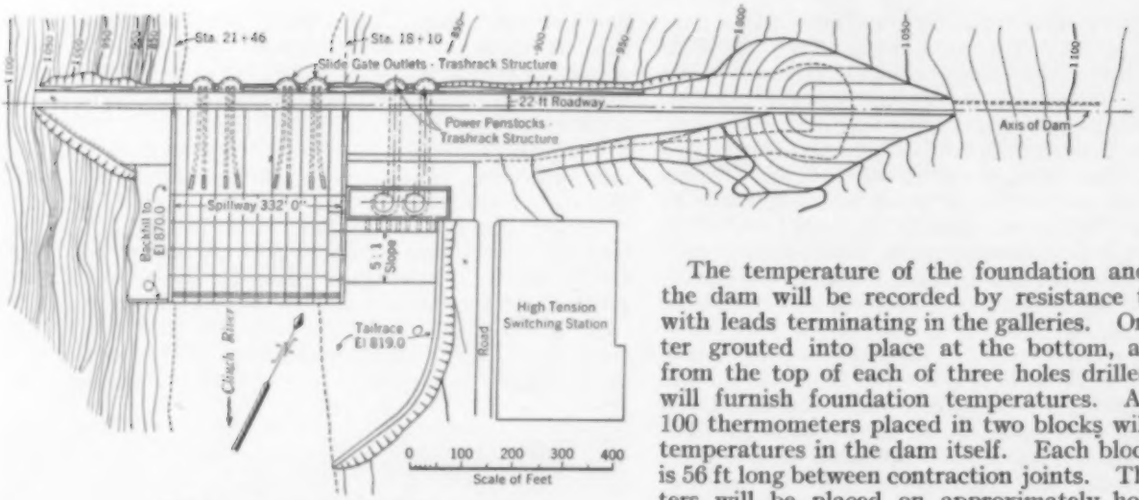


FIG. 1. PLAN OF NORRIS DAM

pressure at the upstream face to zero at the downstream face, or to tailwater pressure at locations where the plane being analyzed is below the elevation of the tailwater surface.

4. Uplift pressures, calculated as in assumption No. 3, act over two-thirds of the horizontal area of the base and over two-thirds of the horizontal areas of the concrete sections analyzed at elevations above the base. Uplift pressures act in the pores of the concrete as well as along the plane of contact between concrete and foundation rock.

5. The maximum earthquake shock will have an acceleration equal to 0.1 that of gravity, a period of vibration equal to 1 sec, and a direction of vibration at right angles to the axis of the dam. When the reservoir is empty, the maximum effect of an earthquake shock will occur during that part of the earth movement when the base of the dam is being forced downstream; that is, while the inertia of the dam is acting in an upstream direction. When the reservoir is full, the maximum effect of an earthquake shock will occur during that part of the movement when the base of the dam is being forced upstream; that is, while the inertia of the dam and water is acting in a downstream direction. The entire effect of an earthquake shock during either condition of reservoir loading is carried by gravity action.

6. Resistance to failure by shear at any elevation is increased by the coefficient of friction multiplied by the summation of vertical forces acting at that elevation.

7. The dam will extend down to elevation 800 in both spillway and abutment sections.

INSTRUMENTS INSTALLED TO MEASURE STRESS AND TEMPERATURE

To minimize leakage and to derive benefit from resistance to twist, all the vertical joints in the dam will be provided with vertical keyways, 6 in. deep, carefully formed in the concrete. In addition, the joints are later to be grouted under pressure through a system of piping, which is being placed as construction progresses. Copper grout seals are being used to confine the grout to each separate grouting area. Each of these areas is 50 ft in height and extends to within a foot of the upstream and downstream faces of the dam. Uplift pressure at the foundation will be measured at 34 points, distributed so as to give five profiles of the pressure gradient. Water that may enter the joint through seams or percolate through the concrete will be conducted in $1^1/_2$-in. steel pipes from small chambers filled with gravel to points under the grouting gallery, and thence through vertical risers into the gallery itself. There the pressures will be determined either by gages or by the elevation of the water in the risers. A similar method will be used to determine uplift pressures on three horizontal construction joints.

The temperature of the foundation and interior of the dam will be recorded by resistance thermometers with leads terminating in the galleries. One thermometer grouted into place at the bottom, and one 15 ft from the top of each of three holes drilled 40 ft deep, will furnish foundation temperatures. Approximately 100 thermometers placed in two blocks will register the temperatures in the dam itself. Each block of the dam is 56 ft long between contraction joints. The thermometers will be placed on approximately horizontal lines normal to the axis of the dam, at elevations about 50 ft apart, and the horizontal spacing of the thermometers will conform to the expected rate of change in the temperature gradient.

Investigation of stresses in the interior of the mass will probably be confined to planes near the foundation, for which locations analytical methods and model studies of dams have not yielded entirely satisfactory results. In each of two blocks, three groups of elastic-wire strain meters will be installed, each group arranged to indicate strains in four directions in a plane normal to the axis of the dam, and also to indicate strains acting in two directions parallel to the axis, and in a horizontal plane. All strain meters are being installed in duplicate. In addition, each group will contain two meters each embedded in a concrete cylinder placed within a recess formed in the dam for reference under conditions of zero stress. The leads will terminate in the galleries, where the resistance readings will be taken by a modified type of Wheatstone bridge. The lowest readable division on the bridge will indicate a deformation of the meter of four-millionths of an inch per inch, equivalent to a change in stress within the concrete of about 14 lb per sq in.

Openings in contraction joints will be measured at various points by elastic-wire meters similar to the strain meters, but with a range of 0.25 in. Approximately 40 such meters will be installed.

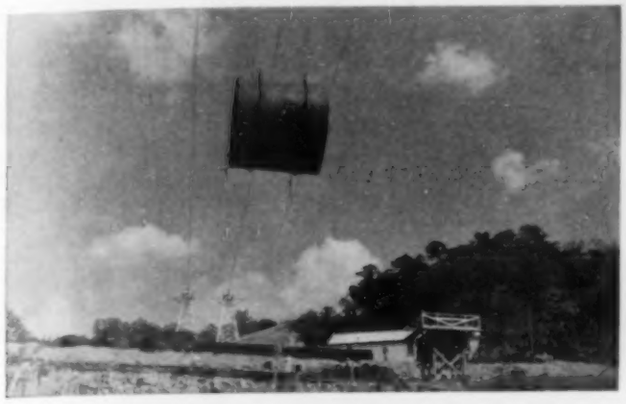
A modified low-heat portland cement is being used exclusively in the dam to minimize shrinkage and cracking. No artificial cooling is contemplated. The amount of cement used in the first 300,000 cu yd of mass concrete has gradually been decreased from 1.10 bbl per cu yd down to 0.95 bbl, due to the favorable quality of the sand being produced. However, the special mixture used on the face contains about 20 per cent more cement.

Both mass concrete and face concrete are deposited by 6-yd bottom-dump buckets, and no mechanical means is employed to separate the two. The result in cross section is a saw-toothed division line, the thickness of the face concrete varying from 4 to 10 ft. The 28-day strength of the mass concrete, wet screened through a $1^1/_2$ in. square screen and tested in 6 by 12-in. cylinders, has averaged a little over 4,000 lb per sq in., and that of the facing concrete about 4,600 lb per sq in. Three electric vibrators, having a rate of about 4,800 vibrations per minute, are operated by each placing gang when handling a 6-yd bucket. At times four vibrators are used.

A near-by quarry of hard dolomite furnishes all the

concrete aggregate. It is quarried, crushed, screened, and stored in six sizes: $^3/_8$ to $^3/_4$-in., $^3/_4$ to $1^1/_2$ in., $1^1/_2$ to 3-in., and 3 to 6-in., besides two sizes of sand. In manufacturing the sand from crushed rock by hammer mills, the expectation of securing favorable gradation and particles of good shape has been realized. The very satisfactory workability and strength of the concrete are evidence that favorable results have been secured from this manufactured sand.

Although keyways are not used on the horizontal joints, every effort is made to secure effective bonding between the new and older concrete. The top surface of the concrete, at the proper stage of hardening, is thoroughly cleaned with a jet, using a combination of air and water under pressure. The joints are on a 5 per cent slope upstream so as to facilitate drainage from the cleaning operations.



PLACING A 40-TON SECTION OF WELDED PENSTOCK
Both Cableways Required for This Load

FOUNDATION OF NORRIS DAM REQUIRES EXTENSIVE GROUTING

Since the foundation is being extensively grouted, the usual cut-off wall along the upstream toe of the dam has been omitted. The east 302 ft of the dam will consist of an earth embankment with a concrete core wall extending to a suitable anchorage in rock.

Geological investigations of the various sites proposed for the dam have indicated that the "Rockhouse" subdivision of Knox dolomite would form the foundation for the dam and abutments. At each site the top of the dolomite was found at an elevation of about 1,060, and that it extended to a depth of at least 200 ft below the river bed was indicated by the diamond drill cores. It is a massive dolomite, generally about 500 ft thick, of medium to coarse grained material, ranging in color from dark bluish gray to light gray or almost white. It contains isolated cavities, an inch or less in diameter, lined with quartz crystals, and its weight is 176 lb per cu ft. Specimens tested broke under compressive loads in excess of 20,000 lb per sq in.

QUARRY AND MATERIALS HANDLING PLANT FOR NORRIS DAM

Horizontal bedding planes in the foundation exist generally at intervals of from 10 to 30 ft, but sometimes they are closer together. Their surfaces are undulating and irregular, and their condition varies from an almost monolithic joint to seams as wide as a fraction of an inch, and occasionally there are thicker seams, including large cavities and caves. The seams and cavities may be open or filled with clay. In general the rock is firm and sound and of a nature favorable to foundation treatment by mechanical means. Sometimes it was found to be more satisfactory to remove the clay under a thick layer of rock and replace it with grout or concrete than to remove the rock. The principal type of foundation treatment being used is pressure grouting, and this is done in all cases with neat cement. The major operation is the complete removal of clay from the seams, accomplished by forward and back washing with water and air, introduced through $2^1/_2$-in. holes 20 ft deep on a 10-ft checkerboard spacing. The air is used to agitate the washing

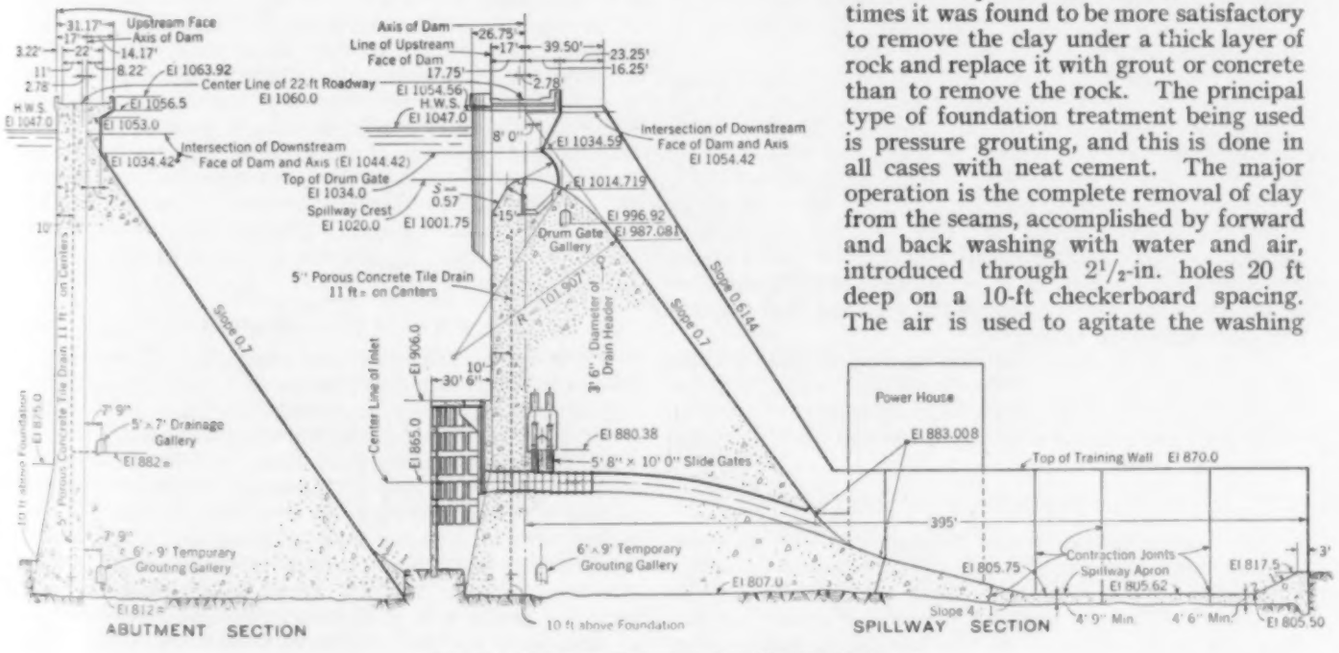


FIG. 2. SECTIONS THROUGH THE NORRIS DAM

water. A 40-ft pattern is drilled, then washed, and finally grouted. Non-adjacent 40-ft patterns are treated likewise, and the intermediate patterns are washed and grouted last. Finally the area, first treated to a depth of 20 ft, is again drilled, washed, and grouted to a depth of 40 ft by means of holes spaced midway between those used in the preceding operation.

STATUS OF CONSTRUCTION ON NORRIS DAM, FEBRUARY 15, 1935
The Two Temporary Concrete Cofferdams Are for Apron of Spillway Stilling Pool

In both the 20-ft and 40-ft grouting it was found necessary to limit washing and grouting pressures to about 35 lb per sq in. to prevent separation and lifting of the rock layers. A device was designed and used which, when anchored into the rock underneath the grouting zone, indicates the slightest motion of the rock surface in relation to this underlying stratum.

In one extensive seam in the east abutment, clay was successfully replaced by hand-tamped concrete. Tunnels on 15 to 25-ft centers were driven parallel to the axis of the dam at elevations such that their roofs were at the seam. The clay in the seam was then removed, one section at a time, by digging from tunnel to tunnel, and after thorough washing the space was back-tamped with a dry mixture of concrete. The tunnels, one of which was 250 ft long, were finally back-filled by gravity flow with concrete delivered at the heading end through a shaft about 30 ft deep. This shaft was drilled from the surface with a 36-in. shot core drill.

The foundation has been thoroughly explored, taking advantage of all the grouting holes, numbering about 4,000, for adding data to the records. In each 40-ft grouting pattern was drilled at least one $5^1/_2$-in. hole, and from it the surrounding rock was explored by a periscope apparatus. Twelve shafts as deep as 50 ft were drilled by a 36-in. shot core drill for exploration purposes. An observer lowered into these shafts could investigate at close range the soundness of the formation and inspect the effectiveness of the grouting in the seams through which it passed.

A gallery is provided near the base of the dam for the deep pressure grouting of the foundation which is to be done after the dam has been built to a height of 100 ft or more. Foundation drainage holes will also be drilled from this gallery.

ENERGY DISSIPATION AT SPILLWAY

The energy in the water passing over the spillway and through the conduits is to be dissipated in a hydraulic jump, which in this case is considered the most feasible method of bringing the water under control and preventing damage to the formation downstream from the dam. Careful experiments with models were made by the Bureau of Reclamation at Fort Collins, Colo., to check the proportions of the hydraulic jump structure.

In the spillway there will be three openings, each 100 ft long, with permanent crests at elevation 1,020, or 40 ft below the top of the dam. Each will be fitted with a drum gate reaching to elevation 1,034 when raised. Under the spillway, and also discharging into the hydraulic jump pool, will be 8 discharge conduits on trajectory profiles with entrance floors at elevation 860, each conduit being 5 ft 8 in. wide by 10 ft high and equipped with two slide gates, in tandem. Each gate will be operated by a 24-in. piston with high-pressure oil. Cast-iron liners are being provided for about 48 ft of each conduit, which will be vented with air by two 12-in. pipes, one connected immediately below each of the two gates.

TWO VERTICAL-SHAFT POWER UNITS

The Norris power house will contain two generating units, each connected without generator circuit breakers to its own bank of transformers, and arranged for synchronization on the high-tension bus. Each unit will consist of a vertical-shaft hydraulic turbine with single cast-steel Francis-type runner, direct-connected to a 56,000-kva generator operating at 112.5 rpm. Although each turbine is guaranteed to deliver 66,000 hp at a net head of 165 ft, it is designed to operate at 60,000 hp at the most efficient gate opening under a net head of 180 ft, and at a guaranteed efficiency of 91.0 per cent. The scroll case will be of the butt-riveted plate-steel type, with an inlet diameter of 20 ft.

Generators are to be of the umbrella type, having a single combined thrust and guide bearing located immediately below the rotor. The top commutator of the direct-connected exciter and pilot exciter will be but 8 ft above the guide bearing. Each generator will be cooled with a closed circuit of air, from which the heat will be taken by water-cooled radiators located within the generator housing. Each 13,800-v, 3-phase, 60-cycle generator will have a rating of 56,000 kva at a power factor of 90 per cent and a guaranteed efficiency at full load of 97 per cent. The over-all diameter of the generator will be 41 ft 8 in.; the rotor diameter, 27 ft 6 in.; and the total weight, 1,375,000 lb.

A separate penstock, with trash rack, and a single roller entrance gate is being provided for each station unit. The steel lining of each penstock is designed to withstand the full internal pressure independently of the surrounding concrete of the dam, and it extends from the turbine scroll case to the concrete bell mouth behind the entrance gate, a total distance of 176 ft. This lining is 20 ft in inside diameter, $1^1/_8$ in. thick at the upper end, $1^3/_8$ in. thick at the lower end, and has electrically welded butt joints.

PROGRESS OF CONSTRUCTION

Work on the cofferdams was commenced November 7, 1933. The construction plant was completed and placing of concrete was commenced in July 1934. This plant includes two 18-ton traveling cableways with a 1,900-ft span, a quarry, a crushing and screening plant with a capacity of over 350 tons per hr, and a concrete mixing plant containing three 3-yd tilting mixers, transporting tracks, cement storage silos, and other items. To February 1, 1935, a total of 380,000 cu yd of concrete has been placed; 270,000 cu yd of rock and 170,000 cu yd of earth have been removed; and 164,000 lin ft of drill holes for grouting have been filled with 90,000 bags of cement in the form of grout.

Common Sense in Structural Design

A Discussion of the Subject from Three Different Points of View

AT the session of the Structural Division on January 17, 1935, during the Annual Meeting of the Society in New York, the three papers here abstracted were read. Each author discusses the subject from the viewpoint of his own specialty. Professor Cross emphasizes the futility of analyses not properly interpreted in terms of design and suggests a basis for such interpretation. In stressing the need for adequate attention to the design of details, Mr. Woodruff states that bridges generally have to be replaced not because of overstress in main members but because of faulty connections. He feels that new materials and new methods should be adopted with caution. In the last article, Mr. Smith warns against blind faith in formulas, against skimped foundations, and against the use of less than 40 lb per sq ft for wind pressures. To further these aims he argues for adequate engineering fees determined on a cost-plus basis.

From the Academic Viewpoint

By HARDY CROSS

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PRECISION in structural analysis is futile in some cases and important in others; the experienced designer fully realizes that analysis of the conventional type is often a poor guide to proper proportions. Certain types of structural action, while essentially of the same general geometrical nature, have characteristics which widely distinguish them as regards interpretation of analyses. The differentiation here suggested has some value in reconciling discordant views held by practical designers and by students of theory. The classes proposed are not sharply defined, but they seem to serve as a convenient basis for considering many structural phenomena.

SUGGESTED CLASSIFICATION

Stresses that either are not due to loads or do not resist any great amount of load may be divided into two classes, deformation stresses and participation stresses; and load-carrying stresses may be distinguished as normal or as hybrid in their action. Deformation stresses result from movements of foundations, from changes of temperature, and from shrinkage. In this type of action, strength has practically nothing to do with the problem. The designer finds it convenient to predetermine the strains, reduce them to equivalent stresses, and deduct these stresses from the working stresses available for load-carrying capacity.

Participation action includes what are commonly known as secondary stresses in bridge trusses; participation stresses in bracing systems; participation stresses in cross frames due to unequal deflection of trusses or girders; cross flexure in the verticals of trusses; secondary flexure in slender columns of bents; secondary flexure in slender spandrel columns of open spandrel arches; and secondary flexure in slender columns of buildings. The allowable value of this participation action varies with the material used, with the importance of the member involved, and with the type of failure that may result. Any generalization about it which does not consider the nature of failure from primary load is misleading.

The term normal is used here to describe the action of those structures or structural parts in which it is possible to determine at the beginning the approximate magnitude of the forces in action, and in which the magnitude of these forces is affected comparatively little by the relative stress in other parts of the structure. The most obvious example is the ordinary statically determinate structure. Most of the classical forms of indeterminate structures belong to this class, although their action is less definite. Thus, in practice, continuous trusses are often designed at once without any exact analysis being made after the design is complete. The experienced designer knows that for these structures such analyses will not indicate any important changes in his design. Other examples are ribbed arches, spandrel-braced arches of steel, and most continuous girders. Rigid-frame bridges, if hinged at the footings, are normal in their action as far as the forces and moments at the knee are concerned. Where the structural action is normal, it is always possible to follow the procedure recommended in most textbooks, that is, to guess at the sections, analyze, revise, re-analyze. These steps rapidly approach a practical design.

Hybrid structural action is here used to mean that action in which two or more parts participate in carrying loads to such an extent that, if the strength of one part is changed, the forces acting on other parts are very much affected. Clearly there is some mutual effect of the parts in the indeterminate structures described as normal in their action. The difference is one of degree, and the two classes merge into each other. Participation stresses also are directly affected by changes in primary stresses, but the relation is not reciprocal. Hybrid structural action occurs in trusses with multiple webs, in king-post and queen-post trusses, in intersecting systems of beams, in Vierendeel girders, probably in most slabs, at least where variation of depth is involved, sometimes in continuous beams, and often in continuous frames.

EXAMPLES OF SUGGESTED TYPES

The distinctions presented are illustrated in the case of a two-legged bent carrying vertical loads. If the columns are very slender the structure is essentially statically determinate although there are participation stresses in the posts or columns. When the columns are very stiff the structure, so far as the columns are con-

cerned, is normal, the stresses in the columns being determined for a fairly definite moment. In the transition stage between stiff and slender columns the structural action is hybrid and does not respond readily to ordinary design procedure. An increase in depth may increase the flexural stress or may decrease it, or may leave it unchanged; and an increase in width, which amounts to an increase in the moment of inertia, produces comparatively little effect. Deformation stresses in such a hybrid structure would be produced by change of temperature. The deformation stresses at the top of the column would vary at first directly as the column depth but for greater depths would be somewhat relieved by flexure of the girder.

Empirical studies must be made very cautiously for structures in which the action is hybrid. There are usually many variables, and the curves of variation present maxima and minima. In this field it is impossible to generalize or extrapolate outside the range of data available, and it is almost impossible to classify the data for study unless the arrangement is based on an adequate theory.

The problem of analysis of rectangular frames for horizontal forces due to wind or to earthquake accelerations illustrates hybrid structural action. Suppose an analysis of a proposed design shows that some girders are overstressed and some understressed. Tradition would indicate a redesign by increasing the size of the overstressed girder and decreasing that of the understressed one. But after this has been done an analysis may show practically the same stresses as before, and in other cases it may show a slight improvement in the stress distribution. This distribution will be further improved by redesigning a number of times, but numerous cycles of redesign may be necessary to produce the desired distribution.

Structures of this type are best studied from the standpoint of the fiber stresses involved. This has been done by H. V. Spurr, M. Am. Soc. C.E., in his wind-frame studies. Without discussing here whether his method of design is necessary, sufficient, or universally satisfactory, it may be stated that his contribution to the direct method of attack is of very great value.

Another important example of hybrid structural action occurs in the case of arches integral with their spandrel construction. If the columns are very flexible all the flexural resistance may be put in the rib or all in the deck girder, or it may be divided between the two in any desired proportion. Of course in any case there must be some flexural resistance in the flexible member and some in the columns. The resulting stresses, however, will have the well-defined characteristics of participation stresses. But as the columns become quite stiff, the picture becomes complicated, and the designer is then dealing with pronounced hybrid structural action. Important studies in this field are being made by Nathan Newmark, Jun. Am. Soc. C.E., Research Assistant at the University of Illinois.

It is not good practice in such arches to abandon a normal structural type with participation stresses for a type that is hybrid in its action. To do so results in obvious reduction in the factor of safety of the rib, gives little promise of economy, and leads to much complication and uncertainty in design. There is little if any evidence from practice that participation stresses in such arches are dangerous or even objectionable. The idea of putting secondary stresses to work is not usually very promising.

Thirty-four years ago Frank H. Cilley presented a paper "The Exact Design of Statically Indeterminate Frame-Works. An Exposition of Its Possibility but Futility," published in TRANSACTIONS, Vol. 43 (1900), page 353, having as its main thesis the principle that "Statical indetermination in a structure is always to be regarded as self-interference with efficiency." This statement certainly represented the views of many, and probably of a large majority, of the leading American structural engineers of his day. Our literature now, on the other hand, contains numerous articles extolling the virtues of indeterminacy. It appears that Cilley's article was devoted too much to a consideration of structures of the hybrid type. The degree of self-interference in normal structures is negligible. Each normal indeterminate structure usually has a determinate analog in comparison with which it has certain virtues, and which has certain virtues in comparison with it. No generalization is possible, but the indeterminate structure has won consideration and its use is often indicated.

From the Viewpoint of the Bridge Designer

By GLENN B. WOODRUFF

MEMBER AMERICAN SOCIETY OF CIVIL ENGINEERS
ENGINEER OF DESIGN, SAN FRANCISCO–OAKLAND BAY BRIDGE, SAN FRANCISCO, CALIF.

PRESENT-DAY bridge designers have several advantages over their predecessors: more complete theory, an immense amount of experimental data, and more reliable materials, as well as the accumulated experience of past years. They have the responsibility of applying these tools, using professional intelligence and common sense. Along with this more general information, the designer has specifications which prescribe in minute detail every step in the calculation of stresses and proportioning of members. In fact there is danger that bridge design will be considered a routine of applying formulas and specification clauses and that proper thought will not be given to each step in the development of the plans. In the design of every structure, regardless of its size, common sense requires that the designer analyze all the assumptions made, estimate the possible errors in them, and also make a careful study of the properties of the materials to be employed.

This procedure involves a certain skepticism as to factors that are generally accepted as facts. It raises the questions as to whether there is sufficient justification for the assumptions customarily made; whether the usual acceptance tests give full knowledge of the materials as they are placed in the structure; and whether the formulas in use are based on assumptions that apply to the materials under consideration and to the conditions under which they are to be placed. From this point of view special caution would be indicated when using new materials, or new methods with proved materials. Requirements during construction, as well as those in the completed structure, should be analyzed and fabrication and erection processes should be modi-

fied in accordance with any peculiar characteristics of the material.

The mathematical work of bridge design should be lessened by making all rules as simple as possible without introducing errors greater than those contained in the underlying assumptions. Column formulas and rules for proportioning details are at present more complicated than can be justified by our knowledge of materials.

IMPORTANCE OF ADEQUATE DETAILING

As a rule, bridges require replacing because of inadequate details rather than because of overstress in main members. The successful design of any structure is more likely to depend on proper details than on correct stress analysis. More experience, greater ingenuity, and broader judgment are required in the development of satisfactory details than in any other stage of the design. Yet engineers are prone to take false pride in the fact that they have served their apprenticeship in this field, often termed "minor work," and have ascended to positions requiring executive ability. The details should give adequate strength and ensure economical construction and easy maintenance. In their development, the designer should visualize the continuity inherent in the usual forms of construction and provide therefor.

To investigate all assumptions and to develop the best details requires more time than is usually allotted to the designer. It would add to the professional standing of the engineer if he would resist the usual demand for speed and refuse to give an opinion until he had had sufficient time for careful thought and study.

As is true of the other branches of the profession, bridge design has become highly specialized. Since it is difficult to maintain a well-balanced judgment in conjunction with specialization, there is danger of losing contact with the other branches of engineering and with the allied sciences. It is possible to go to extremes on one phase of the design and slight other parts of equal importance. An example is the design sometimes seen in which the superstructure is shown in minute detail and practically no attention is given to the foundations.

Even in the restricted field of bridge building, specialization has led to an unfortunate division between design and construction. The designer requires construction experience to visualize all steps in the fabrication, erection, and maintenance of structural steel, the building of forms, and the placing of dense concrete through a forest of reinforcing steel. The constructor requires a sufficient experience in design to appreciate the necessity for the details provided.

CENTER ANCHORAGE OF SAN FRANCISCO–OAKLAND BAY BRIDGE
Top of Concrete 235 Ft Above Low Water, Ready for Erection of A-Frames, Which Receive the Cables; Towers Nos. 5 and 6 in the Background

All these observations may be stated briefly in the words of the late Theodore Cooper, M. Am. Soc. C.E.: "The most perfect system of rules to insure success must be interpreted upon the broad grounds of professional intelligence and common sense."

From the Building Designer's Standpoint

By ALBERT SMITH
MEMBER AMERICAN SOCIETY OF CIVIL ENGINEERS
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COMMON sense is that wisdom which prevents a man from doing what is not worth doing, or from doing what is worth doing with more labor than is required, or from doing inadequately what must be done. To say that an engineer's design shows a lack of common sense seems nearly equivalent to saying that he is not an engineer. To most laymen the engineer's slide rule, formulas, and books of tables seem to make design an exact science. The engineer knows it is far from that.

SAFETY FROM SLOW FAILURE

It is always the engineer's primary responsibility to ensure the safety of the structure. Yet following this principle he may approve fiber stresses in a suspected structure that he would not use in an original design. A structure may be physically ruined as an investment without falling down. The engineer must not allow himself to think that the use of proper limiting fiber stresses in connection with his calculations has ended his responsibility. He is responsible, not only for the safety of human occupants but for the structural safety of his client's investment.

There are cases in which the engineer has commended himself to the client by the false economy of insecure foundations. Sometimes the owner puts strong pressure on the designer to save a small percentage of the building cost by risking the whole value of the building, and sometimes he has to be told to get someone else to make the design. The lack of common sense becomes evident when skimped foundations cause a building to settle, but there are many skimped foundations which still have a safety factor of a little more than one, whose owners do not realize the risk they are underwriting.

Wind pressure, temperature changes, and deformations due to vertical load cause damage and often make necessary continual repairs, which are a burdensome charge on the structure. Partitions are cracked by wind deflection, and expensive stone features are broken where an abrupt transfer of vertical wind stress takes place at an offset. Also, unless the erection of walls is carefully planned with respect to the dead-load shortening of the columns, a building with offsets is likely to have wall cracks. Such cracks once made are apt to recur unless a very expensive job of re-laying is carried out. There is

also the problem of differences in the temperature of columns, which tend to produce resistless shears in walls and partitions.

Some of these things the engineer can prevent or diminish by cautioning the architect. As a matter of conscience it is his duty, and as a matter of common sense it is his business, to explain such factors before the damage is done instead of after.

SAFETY AS AFFECTED BY CONSTRUCTION

Aside from the design, the methods of fabrication and construction may affect adversely the computed stresses in the members. Code specifications and unit loads allow for a certain amount of faulty execution. When the designer finds himself in a difficult situation he often comforts himself by thinking that after all the code provides a large factor of safety.

TOWER NO. 5 FOR THE SAN FRANCISCO–OAKLAND BAY BRIDGE

Hammerhead Cranes Are in Final Position and All Steelwork Is Erected with the Exception of One Saddle Casting

Defective milling of column seats is not the only thing that makes column seating bad. Neither the column depth nor the beam length is exact. When the beams are bolted to the columns, the frame is pulled this way and that to make the errors in general dimensions cause as little harm as possible. This practice may cause considerable eccentricity between two column sections when their milling matches perfectly. Perhaps field welding will make it possible to erect exactly, but its effects should be investigated and not taken for granted. It would be a very common-sense use of time for a committee to study fabrication and erection with respect to column seating and bay length, and if possible prepare specification clauses to improve conditions.

For all foundation work the engineer should insist on a thorough exploration of the earth strata at the site. The decision as to what constitutes "thorough exploration" gives considerable scope for the engineers' exercise of common sense. On the one hand, the owner does not wish to pay for more borings and tests than are necessary, and on the other, unless the engineer has gained a complete and accurate knowledge of conditions the footings may be inadequate or the method of building impracticable.

COMMON SENSE IN RIVET DESIGN

Laboratory tests of rivets indicate that adopted unit stresses in shear and bearing are properly conservative. Yet questions in regard to riveted joints arise on every job. When the designer feels that a larger nominal factor of safety than usual is desirable, he can generally add rivets or increase their diameter, or both—a sensible regulating method, which increases cost very little. When he has added all the rivets that can be crowded in, of the largest size that can be driven in the field, and of a grip equal to or greater than the approved maximum, and still has no more than the conventional unit stress requires, he may not be content with the joint because he knows: that the doubtful connection carries a column with many stories of load; that $1^1/_8$-in. rivets driven by pneumatic rivet hammers do not ordinarily fill the holes completely; that even where they do fill the holes, rivets which are covered with thick scale when taken from the fire may be bearing on iron oxide at the critical points; and that tension tests of long-shear joints may not be representative of the strength of a field joint in which considerable yielding is required in some of the rivets before others will come into action.

The usual device to meet such a situation is to employ tight fitting bolts, but because bolts turned to a tolerance of $^1/_{64}$ in. are rather expensive, the designer is reluctant to use them. On a Chicago building it was found that, as ordinarily heated and driven, 35 test rivets failed to fill the holes, and few had bearing on either side of the main shear section, so that there was wide variation in the amount of yielding of the joint necessary to bring different rivets into shear. Eight rivets heated to light yellow, instead of to bright cherry red, gave better results. For about a thousand second-floor rivets, the engineer prescribed that they should be heated in a gas furnace in such manner that the formed head and half the shank should be light yellow and the projecting half of the shank should be cherry red. The gas mixture was specified to be such that a piece of coke in the furnace beside the rivets would heat without burning.

DEAD AND WIND LOADS OFTEN UNDERESTIMATED

Especial care should be used in computing dead loads. It is not common sense to fool oneself. The engineer who permits dead loads to be underestimated because he thinks that the fiber-stress unit is low or that the code live load is too high, or on any other ground, has lost touch with the real load conditions in his structure. There are so many indeterminates in his work that he cannot afford wilfully to distort any determinable data.

Underestimation of wind loads is equally demoralizing. The stresses the designer considers in his design should be the actual maximum which his structure must endure. There is no doubt that a hundred-mile wind exerts a force of 40 lb per sq ft on the exposed area of city towers. However wind velocity may vary with height, an actual velocity of 100 miles an hour has been observed in New York 500 ft above the pavement.

Wind pressures are greatly modified by shelter. Doubtless a 20-story building erected in a block of 20-story buildings and surrounded by many blocks of 20-story buildings, could be designed for small wind pressures, but such a stituation should be an exception to the code rule. There are very few high towers that are not exposed to the full sweep of the wind from some direction, and the claim that they get some shelter from other towers in their lee is not admissible.

There are several methods by which, with long and tedious calculation, the engineer can derive what seem to be exact wind stresses in a building bent already designed. Aside from the fact that he does not know exactly what length to use for the columns and beams, since he cannot predict exactly what load will come on the different bents, it would seem that such methods are not useful. No one puts a micrometer on the end of a rope; it is not common sense.

For a symmetrical building, the method of designing developed by H. V. Spurr, M. Am. Soc. C.E., can be used

so that the loads and stresses will be developed in action. In an unsymmetrical building the problem is different, since there are a number of cantilever trusses of varying stiffness connected together at each story by a horizontal girder of enormous stiffness. The designer cannot make sure that the fiber stress in the columns due to vertical wind stress is proportionate to the distance from the neutral axis of the bent. The basic assumption of the Spurr method is therefore inapplicable. The designer can and should do much to minimize the unsymmetrical elements, but in most unsymmetrical buildings his problem becomes one of finding a method of design whereby the computed stresses will not too much exceed the actual stresses, which cannot be exactly determined.

The choice between steel and concrete framing generally depends on the advice of the structural engineer and is affected by clearance requirements, time schedules, and other factors. The choice of type of floor construction usually depends entirely on him. Every few weeks some sales engineer brings to the designer's office proposals to supply material or forms for a new type of floor that will save 10 cents a square foot in the cost. Every designer knows that nothing is so unreliable as estimates of comparative costs, since no two contractors will estimate the cost of construction in the same way.

A Chicago engineer once laid out typical floor panels in four types of framing and secured estimates from seven first-class contracting firms. No two of the estimates coincided as to relative cost. Although weighting of the figures gave a fairly clear indication as to which design was the cheapest, this design was most expensive in one set of estimates, and the most expensive design was actually the cheapest in another set of estimates.

The old and reliable tile arch is still a formidable competitor for any type of floor to be used with steel girders. In New York the plentiful supply of a proper cinder aggregate makes steel-beam and concrete-slab construction relatively cheaper than elsewhere. In concrete floors the choice between pan joists, tile joists, and beam-and-slab construction, depending on the spans of the particular building, is a critical test of the designers' judgment. To detect a difference in cost between two methods of framing of 1 cent per sq ft is a delicate task, but this difference may influence the total cost to the amount of several thousand dollars. Neither owner nor architect realizes how important is the quality of the engineer's judgment in such decisions. It appears to be a matter of calculation both in design and in cost, which almost anyone could do, whereas it is really the application of common sense to a problem containing a great many variables.

TEMPER THEORY AND FORMULA WITH COMMON SENSE

Familiarity with the immense amount of literature on the technical analysis of the frames of high buildings would be a wonderful equipment for a building designer. From least work, moment area, and slope deflections, to theoretical discussions of the behavior of soils under stress, it is all important. But the engineer who blindly uses the short-cuts other men have devised, who follows conventional methods and code specifications beyond the limits within which they apply, may be a draughtsman and a computer, but he is not a designer.

Formulas cannot be derived that will give exact answers. They must be started with assumptions and simplified with approximations. They are reliable as to the relative stress in two joints, two members, or two frames, but they do not give absolute stresses that can be correlated with the results secured from specimens in the testing machine.

The experienced designer will have a very definite sense of proportion in any structure he observes. Whether the structure is of steel, concrete, or wood there is a relation between size and load, and between span and height, to which the structure does or does not conform. His eye will pick out the approximate locations of points of contraflexure, and he will estimate roughly the degree of restraint that will be exerted at the joints. There are some men whose perception of these things is almost uncanny. The structural engineer learns something new from every structure, and from the corrections which he so often must apply to his "educated guesses." Common sense may be violated by too much theory, or by too little.

DETAIL OF TOWER NO. 5, WITH SADDLE CASTING OFFSET, SAN FRANCISCO–OAKLAND BAY BRIDGE
From This Position the Saddle Will Be Jacked Into Place After the Hammerhead Crane Has Been Removed

Most design jobs require a large amount of work from the engineer which adds no tonnage to the mill order. Yet the person who retains the engineer, that is, the architect, is apt to see no reason why if an engineer has made one structural design for $2.50 a ton of structural steel, he should not make all structural designs for the same sum, especially since the architect's fee remains nearly constant. Of course the engineer can settle many questions by making sections unnecessarily heavy; he can neglect many considerations where the damage caused will be in materials for which he is not responsible; and he can greatly diminish the amount of work done in the designing office, where it should be done, by forcing the detailer to do it.

It is to be wished that structural engineers could work out some practicable method by which the owner would pay the engineering fees, and perhaps the superintendence fees, both to be brought to a cost-plus basis under the supervision and check of the architect. Designers might then look forward to being able to handle properly the greater responsibility which has come to them as the height of buildings has increased and as their equipment has become more elaborate. Designing structural engineers generally do not expect large profits. As it is, they sometimes make a large amount on one job and lose a large amount on another. The more conscientious and professionally minded they are, the smaller is the profit and the larger the loss.

When fees are skimped the owner always loses, and sometimes he loses more than the whole architect's fee. The present arrangement, by which the limits of the engineering fee are determined by the architect's fee, which is set by those who have no clear idea of what the engineering service should cost, is a bad one. Common sense says that in the long run one gets what one pays for. If the public pays only for poor engineering service, it will eventually get it.

Devices for Measuring Water

Development of New Instruments and Improvement of Old Ones

SINCE earliest times men have found it necessary to measure the volume and weight of water, and today various units for such measurement are in constant use. A more difficult matter is the measurement of water in motion, either in open channels or in closed conduits. Archimedes, Greek mathematician, enunciated a few principles of hydraulics 2,000 years ago. Vitruvius, the old Roman "water master," probably used the orifice to "divide" water. Bernoulli, Bazin, Venturi, Pitot, J. B. Francis, and many others subsequently investigated the laws of flowing water and experimented with equipment by which it could be measured. Today various forms of orifices, tubes, meters, jets, weirs, and gages are available. Three papers on this important subject of water measurement were presented before a joint session of the Power Division of the Society and the Hydraulics Division of the American Society of Mechanical Engineers held on January 17, 1935, during the Annual Meeting. They are here abstracted.

In the first article, Professor Allen and Mr. Hooper present an illuminating record of the degree of accuracy that can be expected from the weir and the Venturi meter when maintained in good condition. They have collated comparative measurements made by these devices over a period of forty years at the Worcester Polytechnic Institute.

In the second article, Mr. Cole explains the technic of using the Pitot tube, which in the hands of experienced men gives consistently accurate results. For obtaining velocities of water in a pipe under pressure, this tube has been developed into a neat and compact instrument that may be inserted through a service cock in the pipe line. The manometer readings may be recorded photographically.

In the third article, Lieutenant Falkner describes a sensitive instrument which has been developed at the U. S. Waterways Experiment Station for quickly and accurately measuring low velocities in shallow water, such as in hydraulic model experiments. This device, the Bentzel velocity tube, has proved so satisfactory that for this use it has superseded the Pitot tube and other means of measuring velocity.

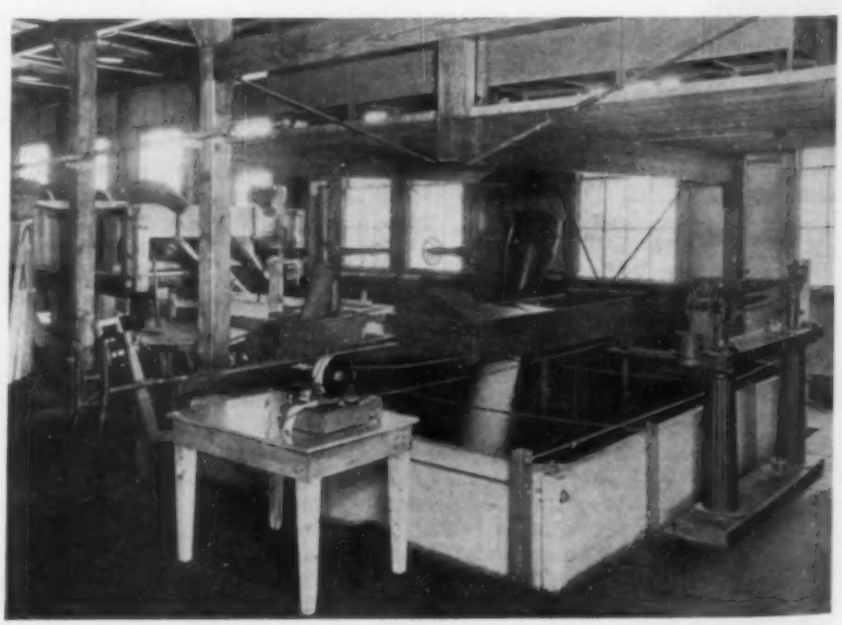
Ten-Foot Weir and Venturi Meter Compared

By C. M. ALLEN, M. AM. SOC. C.E.
and L. J. HOOPER
RESPECTIVELY PROFESSOR AND INSTRUCTOR OF HYDRAULIC ENGINEERING, WORCESTER POLYTECHNIC INSTITUTE, WORCESTER, MASS.

DURING the past forty years a 10-ft contracted weir has been in use at the Alden Hydraulic Laboratory of the Worcester Polytechnic Institute under a great variety of conditions. In that period all the water measured by the weir has passed through a 36 by 16-in. Venturi meter, and thus it has been possible to calibrate one against the other. Since 1922, both the weir and the Venturi meter have been accurately calibrated by the weighing tank at frequent intervals.

In 1894, when the original laboratory was built, it was the consensus of opinion of several noted hydraulic engineers that the contracted weir was probably more accurate than the suppressed weir, since it could be more easily duplicated, and the velocity of approach, being lower, would have less effect. In 1921 when the salt velocity method was used in the 40-in. penstock, it was discovered that the quantities as measured by this method and the weir disagreed by varying percentages over the range of discharge tested. It was at this time that equipment was installed to calibrate the weir by the weighing-tank method, with the result that the weir was found to be in error. The results of this long series of comparisons of weir and Venturi meter are here recorded.

Water is supplied to the laboratory through 350 ft of 40-in. steel riveted pipe. It passes through a 36 by 16-in. Venturi meter on its way to a 110-hp scroll-case turbine, which discharges through a vertical diverging draft tube into the tailrace flume. The Venturi meter



WEIGHING TANK FOR CALIBRATION OF VENTURI METER
Alden Hydraulic Laboratory, Worcester (Mass.) Polytechnic Institute

is of standard construction with a brass lined throat. Since the head at the plant is 30 ft, water manometers have been used in measuring the Venturi deflections. Incidentally it may be of interest to mention that this meter was installed to measure the water used at the World's Fair in Chicago in 1893 and the following year was removed to the Alden Hydraulic Laboratory.

Water is supplied to the weighing tank through a 12-in. pipe line. Switching facilities are provided to divert

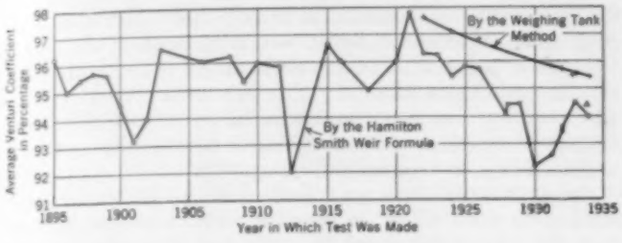
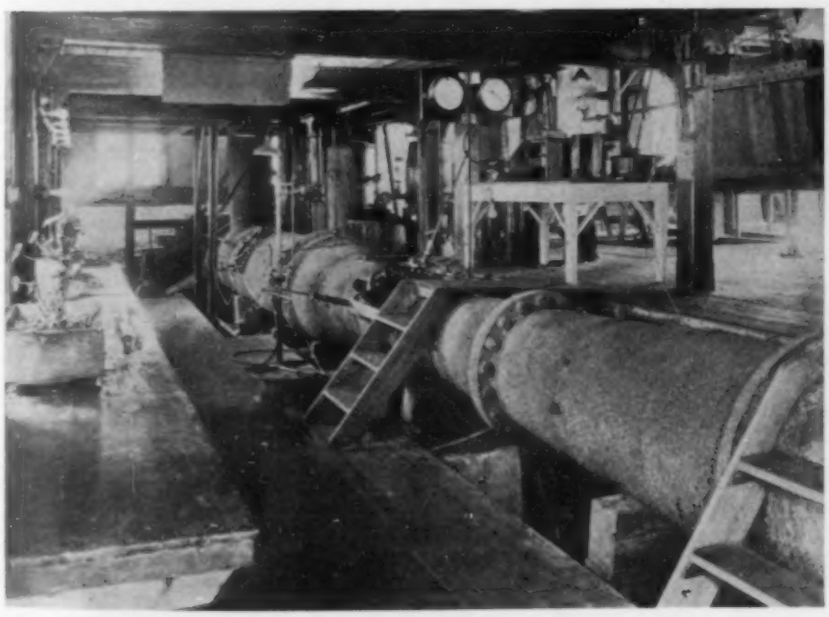


FIG. 1. CALIBRATION OF VENTURI METER BY 10-FT WEIR AND WEIGHING TANK; PENSTOCK CLEANED IN 1903 AND 1921

this water over the weir or to waste it. The runs into the weighing tank were timed either by calibrated stop watches or by chronograph. In either case a contact on the switchway has operated the timing device, so that personal error was eliminated at this point.

The flume in which the weir is placed is 56 ft long and 16 ft wide, and the weir crest has a free length of 10 ft, with contractions at each end of 3 ft. The crest and end contractions are made out of a bronze strip, which was machined straight and sharp at the time of installation. The crest has been machined several times since, the last time just before the calibration of 1926. At the present time the crest is level within ±0.003 ft, and the mean height is used in determining the hook-gage zeros. The sharp edge of the weir has become rounded to a radius of about 0.01 in., and the surface of the bronze plate has become slightly roughened by the action of the water. In this condition the crest is stable in that changes occur very slowly—a desirable situation when a weir is calibrated and in continuous use.



VENTURI METER IN PLACE FOR CALIBRATION
Interior of Alden Hydraulic Laboratory

A perforated piezometer pipe traverses the weir flume 7.4 ft upstream from the crest and 2.5 ft below it. Stilling pots are connected at each end of the pipe, and the head on the weir is measured by hook gages.

From the time the laboratory was first operated until

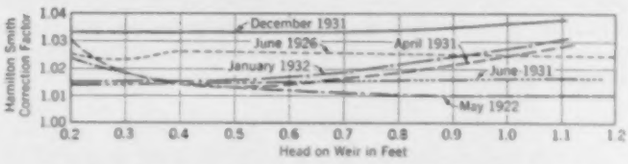


FIG. 2. CALIBRATION OF 10-FT WEIR BY WEIGHING TANK
True Discharge Equals Discharge Secured by Hamilton Smith Formula Multiplied by Correction Factor Here Shown

1922, a large number of comparative tests of the weir and Venturi meter were made. The Hamilton Smith formula,

$$Q = 3.29\left(L + \frac{H}{10}\right)H^{3/2},$$

was used in computing the discharge of the weir in this series of tests because it was considered the most accurate. Until 1922 the coefficient of the Venturi meter was determined by measuring the discharge with the weir, using this formula. Since then the coefficient has been determined by the weighing-tank method.

RESULTS OF CALIBRATIONS

In Fig. 1 the average Venturi-meter coefficient (from 10 to 40 cu ft per sec) is plotted against the year in which the test was made. The test points plotted as circles represent the calibration of the meter by the weir, using the Hamilton Smith formula. The average Venturi-meter coefficient derived in this manner is 0.950, but the variations are relatively large and erratic. Although the mean variation is 1.1 per cent, the maximum variations are −3.2 per cent and + 2.9 per cent. The highest value is 0.978 for 1921 and the lowest, 0.920 for 1912. By way of comparison, the weighing-tank calibrations of the Venturi meter are plotted on the same figure. It will be noted that the coefficient for the Venturi meter in 1922 (within a year of the time that the penstock was cleaned) was 0.976, and that it decreased uniformly until it reached 0.954 in 1934. A comparison of the ratings for the weighing tank and the weir indicates that the weir is responsible for many variations in the ratings of the Venturi meter.

The main reason for the decrease in the coefficient of the Venturi meter over this period of 12 years is to be found in the condition of the walls of the penstock. In 1921 the penstock, including the inlet cone of the Venturi meter, was scraped. The pipe factor—the ratio of the mean pipe velocity to the maximum pipe velocity—of the penstock was 0.84 and the coefficient of the Venturi meter was 0.976. In 1934 the penstock was incrusted with tubercles giving a pipe factor of 0.78 and a coefficient for the Venturi meter of 0.954.

In Fig. 2 are plotted the results of the weighing-tank calibrations of the weir from 1922 until November 1932, when the 4.5-ft channel was removed. The multiplying factor needed to correct

the Hamilton Smith formula varies from 1.010 to 1.038. Within this range there is no systematic variation; some curves are horizontal while others are low at both low heads and high heads and vice versa. The racks and flume were examined and cleaned periodically. Leaves and fish collecting on the rack and sand deposited on the floor, on the upstream side of the racks, apparently caused all these variations. In no case was there any visible change in the flow over the crest of the weir.

CONCLUSIONS SUMMARIZED

As a result of this study of data covering a period of 40 years, a number of conclusions have been drawn. Attention is called to the fact that the weir calibration of the Venturi meter, as plotted in Fig. 1, includes the errors of the Hamilton Smith formula as well as the inaccuracies of the weir for the 40-year period. The coefficient of the Venturi meter, as determined by the weir, varies from 0.920 to 0.978.

The weighing-tank calibration of the Venturi meter, as plotted in Fig. 1, gives a coefficient of from 0.976 for 1922, at which time the penstock and Venturi meter were cleaned, to 0.954 for 1934. The departure of any point from the smooth curve is not greater than 0.25 per cent.

In duplicating test conditions, the velocity distribution in the channel of approach to the weir is very important. This channel should be long and uniform in section. If stilling racks are necessary in the approach to a large weir, of the size here treated, they should be placed upstream a distance at least 25 times the head on the crest. If racks are used, they must be continually examined and cleaned if necessary.

Even though a weir is permanent and substantially built, the zeros on the hook gage must be continually and accurately checked, since this measurement affects all readings of head. A study of the results obtained in this investigation indicates that a weir will give the discharge within 2 per cent under a wide range of conditions provided the approach is good. Poor approach conditions can cause errors up to 15 per cent under low crest heads.

Although the Hamilton Smith formula was derived from weirs of substantially the same characteristics as the one under discussion, it fails to give the true discharge as determined by a weighing tank by between $1^1/_2$ and 2 per cent. If a weir formula is to be applied, all the conditions affecting the flow over the weir used in deducing the formula must be exactly duplicated. If these conditions are not fulfilled, a weir must be calibrated if it is to be used for accurate work.

Apparently the weir and Venturi meter are in the same class with most other devices for water measurement in that they must be carefully calibrated under the conditions of use to give results accurate within 0.5 per cent.

The following quotation, taken from the *Lowell Hydraulic Experiments*, by James B. Francis, published in 1852, indicates that the art in regard to weirs has advanced but little since this monumental work was written:

"No correct formula for the discharge of water over weirs, founded upon natural laws, and including the secondary effects of these laws, being known, we must rely entirely upon experiments, taking due care, in the application of any formula deduced from them, not to depart too far from the limits of the experiments on which it is founded."

The Pitot Tube in Current Practice

By EDWARD S. COLE

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WHEN Henri Pitot, the distinguished French engineer, first held his bent glass tube in the river Seine he started a most interesting development. He discovered that the height to which water rose in his tube was proportional to the square of the velocity of the stream, and so gave to the world the instrument which bears his name. Aside from its extreme simplicity, this device was novel in that it measured velocity without introducing the time element.

Pitot tubes are of two distinct types, simple and combined. The simple form consists of a dynamic orifice and a wall piezometer which measures the static pressure. Contrary to general belief, Pitot used the combined form with double tubes and described it. This was improved 125 years later by Darcy, another French engineer, who in one form turned the static tube downstream and in another gave it only lateral openings, which more nearly read the true static pressure. Darcy calibrated his combined form of instrument in three different ways: by moving it through still water, by using floats in moving water, and by measuring a known flow. He reported its coefficient as close to unity. Bazin made extensive use of the Pitot–Darcy tube and also found the coefficient to be unity.

In the United States, Hiram F. Mills of Boston was probably the first (1875) to experiment with Pitot tubes. For measuring fire-hose jets, John R. Freeman in 1888 used the simple type of Pitot tube and found it accurate within $^1/_4$ per cent. About the same time Henry Flad, of St. Louis, was experimenting with this device. He was probably the first to use photography for recording manometer deflections. In 1896 I began work in this field for the purpose of developing a form of instrument adapted for use in pipes under pressure.

A practical method for measuring water by this device must embody: (1) a suitable means for inserting the instrument into the pipe under pressure; (2) a type of orifice giving consistent readings; (3) a differential manometer free from air for increasingly low deflections; (4) a method of integrating the flow from a velocity traverse; (5) a means for the frictionless recording of manometer

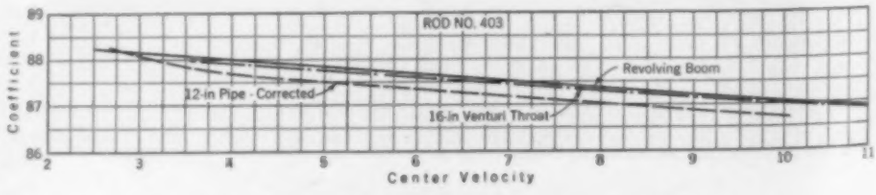


FIG. 1. CALIBRATION OF PITOT TUBE, REVERSIBLE TYPE

deflections; and (6) a reliable means for calibrating the instrument. The solution of these problems has involved a long study.

A stuffing box screwed on the standard 1-in. corporation cock was the natural means of inserting the Pitot tube into the pipe. For insertion through a valve in pipes under pressure, the usual long and pointed Darcy type of tube is quite impractical, and the more compact, folding, and reversible type illustrated is preferred.

When air stood above the columns of measuring liquid in the manometer tube the columns were found to fluctuate so rapidly that it was impossible to read the instrument with any precision. It was only when all air was excluded from the manometer and connections, allowing water to fill the U-tube above the heavier and immiscible liquid, that reliable readings could be taken. With the velocities of 1 ft per sec and lower commonly found in water mains, readings are so small that carbon tetrachloride, which has a specific gravity of 1.25 and provides for a 4 to 1 magnification, has proved most useful. Photographic methods have been developed to record manometer readings as well as pressure and temperature changes.

THEORY DEVELOPED

The theory of the dynamic tube or orifice has been well developed. The law is that $V = c\sqrt{2gh}$. The theory of the static orifice is more complicated.

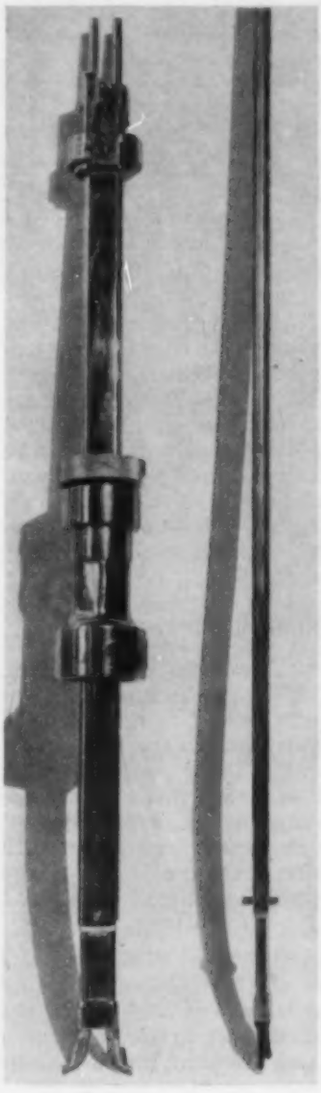
The simple type of Pitot tube, with its forward facing tube, reads the dynamic head in an open stream or the dynamic head plus the static head in a pipe. For pipes the static pressure must be deducted by means of wall piezometers. Gibson says that the "coefficient of the simple type is sensibly equal to unity."

The combined type of Pitot tube was first used by Pitot himself in order to give the true level of the open stream. As has been said, it was much improved by Darcy about 1858. He reduced the vibrations of the water columns by using orifices much smaller than the tubes. His static pressure was obtained by drilling small holes perpendicular to the flowing stream in the wall of the plugged and forward-facing second tube, which lay close beside the dynamic tube. Darcy also turned his static tube downstream as an alternate form. This combined type of Pitot–Darcy tube became the standard instrument for open-stream measurements and has been little improved up to the present day. For this purpose its coefficient was found to be close to unity both by Darcy and by Bazin.

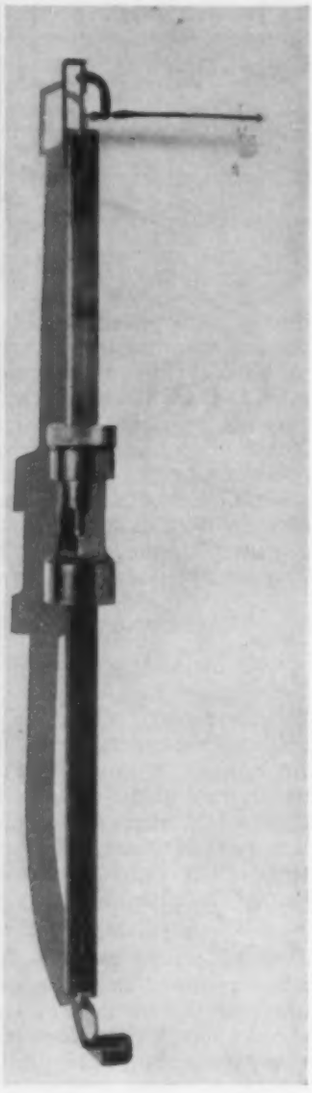
Calibrations of the Pitot tube may be made in moving or in still water. In moving water the readings are compared with velocity as given by floats in an open stream, or if the rating is in a pipe, the Pitot tube itself is used to compute the mean velocity from a velocity traverse, which is then compared with the mean velocity given by weir or tank measurements. A still-water rating may be secured by moving the Pitot tube ahead of a boat drawn at known speeds or by driving the tube through the water by means of a revolving boom or a car running over a tank.

Where the shape of the Pitot tube causes a change in the projected area while traversing, some correction for the presence of the tube must be made if its coefficient is to be compared with that obtained in another size of pipe, in still water or in a large Venturi meter. Where the Pitot tube is supported on a stream-lined rod passing entirely across the pipe so that a traverse involves no change in the projected area, some correction must still be made. This correction has never before received proper attention, a fact which may account for apparent inconsistencies in Pitot tube calibrations.

In order to study angular flow in pipes, the device illustrated was constructed with a cross shaped vane free to move with the water in any direction up to about 30 deg from the pipe axis. The effect of friction and inertia on this indicator was made as small as possible by mounting its shaft in stainless steel ball bearings. Its behavior in a 12-in. pipe was observed under conditions of normal flow and also with distorted flows such as are produced by bends or by a partly opened gate nearby. With normal flow, readings failed to show an average angularity as great as 5 deg. The indicator was in constant and rapid vibration through small angles with an occasional jump to 10 or 15 deg for an instant only. When the reversible Pitot tube is rotated through an angle of 5 deg, it over-reads the cosine value by 1 per cent.



REVERSIBLE TYPE OF PITOT TUBE



TUBE FOR STUDYING ANGULARITY OF FLOW IN PIPES

Broadly speaking, the Pitot traverse method may include gagings made with the simple Pitot tube and wall piezometer, but here we are chiefly concerned with the combined type. Although many important gagings have been made, it is difficult to lay down a simple rule for guidance in selecting the gaging point. Actual con-

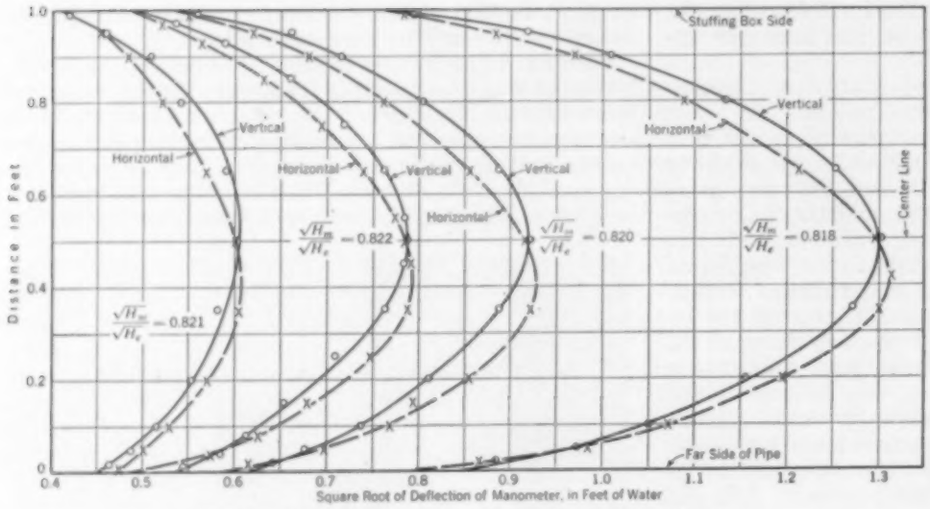


FIG. 2. SAMPLE PITOT-TUBE TRAVERSE IN 12-IN. PIPE

ditions must govern, and often it is necessary to accept the best compromise location and make trial velocity traverses of the pipe to indicate the suitability of the gaging point. Here as elsewhere there is no substitute for experience. In general, the longest possible straight length of pipe upstream from the gaging point should be selected, and this point should not be too close to a downstream bend or fitting. Sometimes a length 10 or 15 diameters upstream, and perhaps 2 to 5 diameters downstream will give good results, depending on conditions both of pipe line and of flow.

TRAVERSING AND RING INTEGRATION

The method of ring integration used at the Alden Laboratory is as follows. The square root of the Pitot tube manometer deflection was plotted to a large scale, and smooth curves were drawn through the test points. An example is shown in Fig. 2. Forty readings of the square root of the deflection were then taken from these curves and averaged to obtain the mean square root. The readings were taken at the center of gravity of 10 rings of equal area, the position of the centers of gravity being determined by the following equations: Ring No. 1 $= R\sqrt{0.05}$; Ring No. 2 $= R\sqrt{0.15}$; Ring No. 3 $= R\sqrt{0.25}$; Ring No. 4 $= R\sqrt{0.35}$; etc. This system is more accurate than the use of the midpoint of equal areas or the average of the boundary readings of the equal areas. The errors of computation are small if as many as ten rings of equal area are used, and if two diameters at right angles are traversed. It is well to have one diameter in the plane of an upstream bend in order to judge the lack of symmetry in velocity distribution. With unsymmetrical curves, it is not safe to assume that the horizontal traverse has the same ratio of mean to center as the vertical traverse, even though they have the same center velocity. With two traverses 90 deg apart, there are of course four values of velocity for each ring.

In making velocity traverses it is important to secure readings close to the wall of the pipe, and to do this the orifices are formed, as in the tube illustrated. It is good practice to remeasure the center velocity at frequent intervals during a traverse in order to avoid readings that are not comparable because of a change in the cycle of flow variation. When traversing with unsteady flow, as in water mains or power penstocks under variable load, it is convenient to use a fixed pilot meter set near the point of maximum velocity so that readings may be taken only at some predetermined rate.

When the mean velocity has been thus obtained, the pipe factor or ratio of mean to center velocity is computed. In straight pipe lines, this is a criterion of the roughness of the pipe wall, and in any pipe line it reveals the suitability of flow conditions at the gaging point. After the pipe factor is known, a continuous record of center velocities only will indicate the discharge. This factor may remain constant for a given gaging point in a given pipe for a considerable period of time.

As a device for measuring water in pipes under pressure, the Pitot tube, both simple and combined, is excellent. In the simple and the Darcy combined types, the coefficient is practically unity. The coefficient of the reversible type must be obtained by calibrating the instrument. A sample calibration is shown in Fig. 1. A study of angularity of flow in normal pipes indicates that it seldom exceeds 5 deg and that Pitot tube measurements are but little affected by this angle. Ratings of tubes in still and in moving water agree within $\frac{1}{2}$ per cent, but still-water ratings when used for pipes must be corrected for the presence of the tube. In the hands of trained and experienced men this device is a useful and accurate instrument.

The Bentzel Velocity Tube

By FRANCIS H. FALKNER

JUNIOR AMERICAN SOCIETY OF CIVIL ENGINEERS

FIRST LIEUTENANT, CORPS OF ENGINEERS; DIRECTOR, U. S. WATERWAYS EXPERIMENT STATION, VICKSBURG, MISS.

PRECISE instruments for measuring the velocities of water flowing in open channels are required by the experimental methods of the U. S. Waterways Experiment Station. The large reduction in scale from prototype to model creates the necessity for measuring very low velocities and procuring repeated measurements in short periods of time. The shallow depths normally used in hydraulic models further militate against the use of standard current meters and require point measurements. Velocity measurements are often required in channels only 0.05 ft deep. These requirements presented many difficulties to model technicians until, in the fall of 1932, Carl E. Bentzel, Research Assistant at the Station, developed a new device for measuring velocity.

A limited patent on this instrument is being secured by Mr. Bentzel, but the right of manufacture and use is retained by the U. S. Government.

THE PRINCIPLE OF THE BENTZEL VELOCITY TUBE

The instrument, shown in Fig. 1, consists essentially of a U-tube with both ends turned through 90-deg, a tapered glass tube in the downstream leg, a priming device, and a float in the tapered section. When the instrument is filled with water by extraction of air through the priming cock, and the lower ends of the tube are held in still water, no flow exists and the float rises and rests against the wire stop. The float is made of capillary glass tubing containing a small piece of colored wax, closed at both ends, and so constructed as to have a very slight buoyancy.

If the water in which the ends of the tube are immersed be set in motion, a positive velocity head is created at the entrance to the upstream leg and a negative head at the downstream leg. This difference in head causes the circulation through the tube of a small quantity of water, the amount being dependent upon the velocity of the water flowing past the instrument. This circulation or flow through the tube causes the float to be pushed down until at some point within the tapered section the unit impact force of the water, reduced by the enlarged section, exactly balances the buoyant force of the float. The position of the float, when it comes to rest, serves as a measure of the velocity. It has been found that this instrument can be calibrated very closely by towing it through still water, and that for every velocity of flow within the range of the instrument, there is a corresponding position of the float within the tapered section.

This principle can be applied with the expanding tube in either the upstream or downstream leg of the instrument. In the former case, the direction of taper is reversed and a "sinker" is used instead of a float. About 5 deg has been found to be the maximum divergence of the tapered section for efficient operation of the instrument. In order to increase the range of a particular instrument, a small cap with a fine capillary tube can be inserted in the upstream leg to increase the resistance and reduce the quantity of flow through the tube.

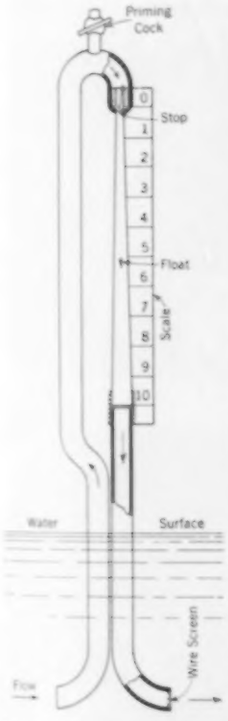


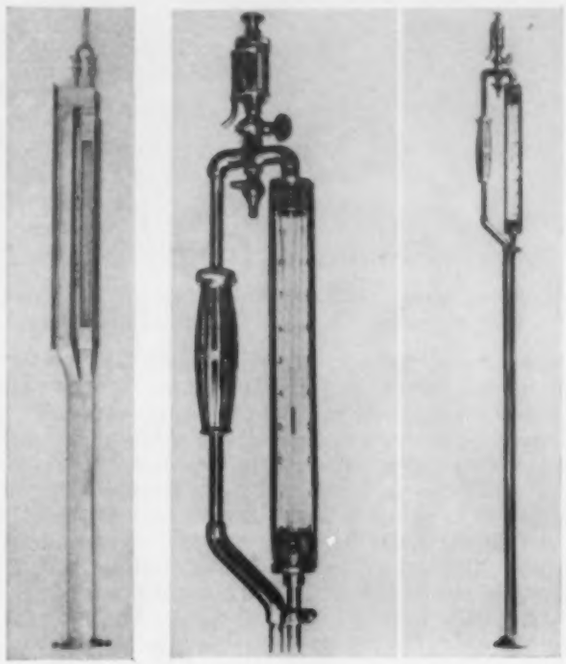
FIG. 1. ARRANGEMENT OF PARTS IN BENTZEL VELOCITY TUBE

ACCURACY OF THE INSTRUMENT

In accuracy and reliability, a well-designed Bentzel velocity tube compares favorably with the standard devices commonly used for measuring the velocity of flowing water. The instruments fashioned in the shops of the U. S. Waterways Experiment Station are mechanically accurate to within 1 or 2 per cent.

Whereas it was noted that the float remained perfectly still when the tube was towed at constant velocity through still water, it was found that the float would rise and fall in an irregular manner when the tube was used to measure turbulently flowing water. In order to determine whether these variations were due to turbulence set up in the tube itself, measurements were taken of laminar or streamline flow. It was found that the float stood perfectly still, which seems to indicate that the fluctuations were due to the ever-changing velocities which are characteristic of turbulent flow. Consequently, when turbulent flow is being measured, the average position of the float is taken as a measure of the mean velocity. This may introduce a small error due to the subjective judgment of the observer. The error thus introduced, however, is within the limits of accuracy required for stream discharge measurements.

One source of error, that due to the formation of air bubbles in the tapered tube, has been largely eliminated. It was found that if the temperature of the water passing through the tube was considerably less than that of the air around the tube, air bubbles would form and tend to collect on the float, thereby changing its buoyancy and producing erroneous readings. This difficulty has been minimized by the addition of a jacket in which the water will circulate in a manner similar to that in the tube itself. Since the density and viscosity of water varies with its temperature, a correction for temperature must be applied if it differs from that of the water in which the float was calibrated. Experiments have shown that a straight-line variation of velocity with temperature exists for each scale reading; calibrations at any two temperatures make it possible to interpolate the velocity corresponding to any scale reading at any temperature within the range.



TWO TYPES OF INSTRUMENT
Left, As Made by the U. S. Waterways Experiment Station; Right, Two Views of Commercial Instrument

USES OF THE BENTZEL VELOCITY TUBE

The special field of application of the Bentzel velocity tube is in the accurate and rapid measurement of very low velocities. Although tubes have been used to measure velocities up to 7.0 ft per sec, the primary advantages of the device are in the measurement of those ranging from 0.15 ft per sec to 3.0 ft per sec. Since current meters, Pitot tubes, and Venturi tubes attain their greatest accuracy at higher velocities, the Bentzel tube

serves to lower the limit to which accurate velocity measurements can be made. It fills a gap among hydraulic instruments, of which hydraulic engineers have long been aware.

In addition to its ability to record low velocities accurately, it has the additional advantage of giving almost

MEASURING WATER VELOCITIES IN MISSISSIPPI RIVER MODEL
At U. S. Waterways Experiment Station, Vicksburg, Miss.

instantaneous readings. This rapidity of action is valuable to the laboratory technician. A photograph shows a Bentzel velocity tube being used to take discharge measurements in a model of the Mississippi River. For this type of work speed is essential. In some instances the stage in this model is maintained for as short a period as 15 min. During this time a complete set of measurements must be made across the cross section. With the Bentzel velocity tube mounted as shown, the velocity at the first point can be read and the instrument moved to the next point in 30 sec. Allowing time to obtain steady flow, 20 velocity measurements can be taken. This rapidity of measurement makes it possible to take discharge measurements in the model in a manner very similar to that employed on the prototype.

This use of the instrument is especially important in cases, such as the one illustrated, where the river divides into two or more channels. Likewise, in models requiring a careful adjustment of the distribution of kinetic energy in the cross section, the use of the Bentzel velocity tube has many advantages, primary of which is its accuracy for velocities less than 0.5 ft per sec. These low velocities are to be found at certain points in most river models.

NEW DESIGNS AND USES

A new type of Bentzel velocity tube, as commercially manufactured by Leupold Volpel and Company, is illustrated. In this instrument the taper of the glass tube is reversed, the tapered section is inserted in the upstream leg, and a non-breakable "sinker" is used instead of a float. The principle of this instrument, suggested to the company by Mr. Bentzel, is identical with that of the ones previously described. The "sinker" is forced up in the expanding tube by the impact force in the enlarged section. The substitution of a non-breakable sinker and the addition of a vacuum pump to each instrument are the two notable improvements.

Some experimental work has been done at the U. S. Waterways Experiment Station in an effort to adapt the Bentzel velocity tube to stream gaging work. The first instrument that has been constructed for this purpose consists of a tube of standard design but having an overall length of about 11 ft. The obvious difficulty in using it is its weight and size, which make it unwieldy. Despite this drawback, it is believed that the tube can be used advantageously to obtain direct velocity readings by the installation of a simple handling rig, such as an overhead cable, at a permanent gaging station located on an irrigation canal or a similar ditch where the water is not deeper than about 6 or 7 ft. Much remains to be done in developing its use and application for this purpose.

BENTZEL VELOCITY TUBE USED FOR STREAM GAGING
Of Standard Design but 11 Ft Long

CALIBRATING A BENTZEL VELOCITY TUBE BY HOLDING IT IN A FIXED POSITION IN A ROTATING TANK

Depression Activities in Wisconsin

Program of Park and Parkway Development in Milwaukee County

By William F. Cavanaugh

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LACK of proper planning has been responsible for poor results in the working out of certain emergency relief programs. However, Milwaukee County, Wisconsin, has suffered no such handicap in its program of developing its park and parkway system as a relief measure. Through competent planning and the cooperation of city, county, and Federal authorities, the Milwaukee County Park Commission has worked out its relief program with outstanding success. The results of these depression activities were described by Mr. Cavanaugh in a paper presented before the City Planning Division on January 17, 1935, at the time of the Annual Meeting, and here abstracted.

PRIOR to 1931 practically all major construction activities in the Milwaukee County system of parks and parkways were handled by contract, under the direction of the Milwaukee County Park Commission, and paid for from budgetary appropriations. All county engineering activities are centered in the Milwaukee County Regional Planning Department which, in addition to functioning as a planning body, deals with problems of zoning, platting, locating thoroughfares, issuing building permits, and the like and also serves as the engineering staff for the county park commission. Since the establishment of this department by the Milwaukee County Board of Supervisors in 1924, at the request of the County Park Commission, it has been the policy of the commission to carry out its park construction projects only in accordance with definitely approved plans. Haphazard, poorly conceived schemes were therefore shelved as inappropriate.

Early in the depression it became evident that the development of the Milwaukee County system of parks and parkways could not proceed in accordance with a planned program because of the lack of appropriations in the park commission budget for contract construction. Thus the commission was faced with the paradoxical situation of having its own funds for park improvement and construction decreased, while relief expenditures for such items as food, clothing, and rent were rapidly increasing. Construction work on the parks and parkways was practically at a standstill.

The problem was finally solved when the Milwaukee County Board of Supervisors appropriated a special fund of $100,000 to be expended on relief work in the parks and parkways. Special consideration was to be given to "border-line cases," that is, persons who needed relief but who still had some unexhausted sources of income, however small, that kept them from obtaining direct relief.

Under the employment program thus initiated by the board, employment was arranged on the basis of 8 hr of work per day for 4 days a week at a rate of 50 cents per hr. Thus the maximum earned in any one week was $16, or $64 for a 4-week period. For those on relief, deductions in salaries were made for supplies that had been obtained from the Department of Outdoor Relief during the period of employment.

Appropriations for Relief

Shortly before the funds initially set up were exhausted, the county board appropriated an additional $100,000 to the County Park Commission for a continuation of the work-relief program. Inequalities that had arisen under the initial plan, resulting in some instances in no cash payments to men on relief who had large families and had drawn more than their earnings in supplies, were remedied by paying a minimum of $1 per day in cash to all workers on the relief rolls. In February 1932 another appropriation, amounting to $50,000, was made by the county board. This was to be utilized in the payment of wages, preference being given to border-line cases most urgently in need of assistance.

The program of employment that finally resulted, after many trials and changes, was one meeting with general favor from the press, the taxpayers, and the recipients of employment. From the outset, the selection of the types of work suitable for hand labor was a problem. Experience soon proved the fallacy of the assumption that men might be turned into new park areas by the hundreds, without special provision being made for definite work projects. Clean-up work, trimming, and brushing were done with such vigor by men unfamiliar with the work that the parks soon were in grave danger of being permanently and irreparably damaged. The task of preparing detailed construction plans for the laborers in these park areas fell to the planning department.

Fortunately general development plans had been pre-

Constructing the Pool

Completed Warming Basins

Overflow from Lower Warming Basin

Swimming Pool Facilities in Greenfield Park, Milwaukee, Built by Relief Labor

pared by the department's landscape architects and engineers in advance of the work program. The basis of these plans was a detailed topographic survey made by the engineers in the department This survey had been secured with sufficient accuracy to enable the preparation of grading plans for lakes and lagoons, without the necessity of obtaining additional field data.

GAULT BRIDGE ON HONEY CREEK PARKWAY
Built by CCC Labor

It was also used in the computation of run-off for storm sewers and other drainage structures. It has always been the policy of the department to make complete surveys of all park and parkway areas immediately after acquisition.

TYPES OF WORK PERFORMED

The simplest form of work on which relief labor was employed was the grading of the drives in the new park and parkway areas. Although most of the earth moving was done by pick, shovel, and wheelbarrow, this method was supplemented by the use of teams and dump wagons, with occasional trucks, where the hauls proved to be too long for wheelbarrows. A considerable mileage of parkway and park drives has been graded, the former to a width of 36 ft, and the latter to a width of 30 ft. Catch basins and storm sewers were provided where necessary to carry rainfall run-off from the roadways themselves, and to provide the drainage for ditches or swales crossed by the drives. The areas back of the curbs, including the slopes in cuts and fills, were landscaped to fit the original topography.

To provide employment for skilled labor, the necessary bridges and culverts on the newly graded park and parkway drives were constructed. These structures ranged from small reinforced concrete culverts to slab bridges of 25-ft span and reinforced concrete arches. Stone facing was placed on all the structures, limestone being used for some and cut field stone for others. The bridges were designed in cooperation with the landscape architects of the planning department, and an extremely picturesque group of structures has resulted. Although the bridges are similar in general plan, enough variation has been introduced in the details to make each structure a pleasing unit. Greater interest in these projects was shown by the relief workers, and a higher efficiency resulted than in other operations calling for merely manual labor.

To provide swimming facilities for the western part of the county, which is not readily accessible to Lake Michigan or the beaches on the Milwaukee River, the County Park Commission approved the construction of a swimming pool in Greenfield Park as a relief project. The design for the pool, with all its accessories, was prepared in the office of the planning department. Since Greenfield Park is located some miles from the nearest city, there was no supply of water available without recourse to the drilling of a deep well. Tests showed that deep-well water has a temperature of about 52 F, while for swimming the desirable temperature is about 70 F. This presented the problem of how to provide swimming facilities without constructing a recirculating system, which would be prohibitive in cost. After some study, the use of warming or tempering basins was decided upon. In these basins, exposure to the sun's rays and the atmosphere warms the water before it flows into the pool. Successful operation for a period of three summers has proved the soundness of the design.

Briefly, the method of operation is as follows. The water is pumped from a deep well located at a relatively

POURING TENNIS COURTS IN ESTABROOK PARK
Relief Laborers at Work

high point in the park. It then gushes forth from an artificial rock formation simulating a spring in appearance, and, exposed to the air, tumbles down a rock rill into the upper of two warming basins. Separating the upper and lower basins is a weir, or rapids of native boulders, 1 ft in height. Thus the surface water from the upper basin is skimmed off and flows into the lower basin, which is provided with a small dam at its outlet. After passing over this dam, the water flows by means of gravity through a pipe line to the reinforced concrete swimming pool of 780,000-gal capacity, entering the latter through three inlets located in the center bottom. The pool is oval in shape and measures 200 by 170 ft. The depth of the water around its entire edge is 18 in., while the center depth is 9 ft.

TREATMENT OF WATER

The water is chlorinated before entering the pool, and around the entire periphery there is a scum gutter that removes the surface water. Fresh water flows constantly through the pool, while an auxiliary line connecting the deep well and pool is used when the temperature in the pool becomes excessively high. Provision is also made for complete drainage of the pool through the bottom, and the supply and discharge pipes are equipped with valves for positive control. After the water leaves the pool, it feeds an artificial lake that covers an area of nine acres and is one of the principal features of the park. From this lake it passes into an area now being developed into an aquatic or bog garden for the growth and display of all forms of aquatic plants, flowers, and mosses indigenous to the region. Except for the excavation of the lake, the entire project was performed by relief labor.

At Estabrook Park on the Milwaukee River a swimming beach was constructed by the use of picks, shovels,

and wheelbarrows. Although this was a comparatively small grading job, it transformed a "swimming hole," which was dangerous because of the presence of deep water resulting from past quarrying operations, into a safe and attractive swimming beach.

Under construction at the present time at Silver Spring Park is a reinforced concrete pool with a capacity of 950,000 gal. While the use of a deep-well pump and a single large warming basin has been resorted to—as at Greenfield Park—there is insufficient difference in head between the warming basin and the pool to make it feasible to rely solely on gravity as a means of supply. A centrifugal pump, so designed that water may be taken from the warming basin, pool, or deep well, will force water under pressure into inlets located in the side walls and bottom of the pool. Provision is being made for adequate chlorination and ammoniation of the supply in this pool, and present plans provide for the operation of the pool in the summer of 1935.

REMOVING ROCK BARRIER IN THE MILWAUKEE RIVER
A Flood-Prevention Project Constructed in Estabrook Park by CCC Labor

VARIED PROJECTS UNDERTAKEN

Because of excessive erosion at bends along some of the streams in the parkway system, revetment and retaining walls have proved desirable. Wishing to retain the natural appearance of the stream, the landscape architects and engineers of the planning department have utilized native limestone from the County Park Commission quarry as well as field stone. As in the construction of the bridges and pools, this work offered an opportunity to employ mechanics or skilled tradesmen, as well as laborers. In the various parks four small lagoons, comprising 4.2 acres, were excavated, graded, and landscaped, principally by hand labor.

Begun as CWA projects in December 1933, buildings representing an outstanding accomplishment in design and construction have now been completed. These structures, which were designed by architects and engineers employed in the planning department, testify to the high degree of workmanship attainable under relief labor. Included among the structures are the following: the Estabrook Park Service Building, a stone and timber structure of Norman architecture; the Grant Park Bath House, a modern interpretation of Colonial architecture; the Jacobus Park Shelter, a Cape Cod cottage design; the Kletzsch Park Pavilion, embodying Swiss architectural features; the Silver Spring Park Bath House in Cape Cod Colonial style; and the Oak Creek Parkway Pavilion, representing the English Cottage type. The construction work on the buildings was done entirely with CWA, FERA, and WERA labor, funds for materials being supplied jointly by the Federal Government and Milwaukee County.

To obviate the necessity of continuing the use of septic tanks in Greenfield, Grant, and Brown Deer parks, sanitary sewer systems were constructed, using 6, 8, and 10-in. pipes leading to intercepting sewers.

Grading work, under contract, was completed on the Oak Creek Parkway Drive in 1930. Later, in order to utilize this drive it was decided to place the surfacing with relief labor. Consequently a vertical concrete curb was installed, and a penetration tar macadam was placed. Also a pavement with concrete curb was installed in Brown Deer Park, the total construction amounting to 47,000 sq yd of pavement and 18,600 lin ft of curb.

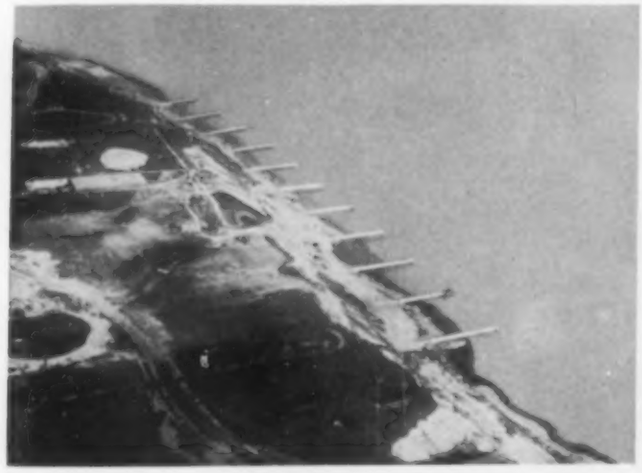
PROJECTS OF THE CIVILIAN CONSERVATION CORPS

In May 1933 the Milwaukee County Park Commission made formal request to have three Civilian Conservation Corps camps, operating under the direction of the National Park Service of the Department of the Interior, located in three of the county parks. Inspectors from Washington visited the park system and examined the plans on file in the office of the planning department, to ascertain if there would be sufficient work for the occupants of these camps. As a result of this investigation, Milwaukee County was granted three camps, which were installed July 1, 1933. These CCC camps are still in operation and have been augmented by two new camps.

Each camp consists of a company of 250 enrolled men, ranging from 18 to 25 years of age, in addition to the officers and supervisory personnel. The term of enrolment is one year, after which the men are replaced by new candidates. In a remarkably short time, these men adapt themselves to their new lives and, under proper supervision, produce truly amazing results. All plans for the work in the CCC camps are prepared in the office of the planning department, are approved by the district office of the National Park Service, and are executed under the joint supervision of the planning department and National Park Service inspectors.

The work being done by the CCC camps includes, among various interesting projects, the construction of

jetties in Sheridan Park. The shore line of this park, located on the exposed shore of Lake Michigan, was receding and causing a gradual decrease in the area of the park. Sliding of the face of the bluff, which at one point reaches an elevation of 120 ft above lake level, has been progressing continuously. The bluff is comprised of heavy strata of clay, alternating with thinner layers of sand carrying subsurface water. At the face



JETTIES PROTECTING THE SHORE OF LAKE MICHIGAN
Built in Sheridan Park by CCC Labor

of the bluff the continual seepage from the sand layers saturates the clay sufficiently to cause sliding because of the heavy overburden. There was practically no beach, and storms removed from the base of the bluff material previously placed there by the slides.

PLACING OF DRAINS AND CONSTRUCTION OF JETTIES SUCCESSFULLY ACCOMPLISHED

In attacking the problem, drains were placed down the face of the bluff to the water's edge, with laterals tapping sand pockets that showed evidences of seepage; surface drainage was also carried down the bluff face by means of storm sewers. Intercepting tile drains were constructed parallel to the bluff to cut off subsurface water before it reached the exposed face of the bluff.

Then jetties were constructed at right angles to the shore line at 200-ft centers and extending about 200 ft into the lake. These jetties, constructed of pre-cast reinforced concrete units, were of a permeable nature, experience elsewhere on the western shore of Lake Michigan having proved the soundness of the principle upon which the design was based. The velocity of littoral currents carrying sand was retarded by these jetties and the sand was deposited, thus resulting in beach accretion. To date 11 jetties have been constructed in Sheridan Park. The concrete aggregate, both coarse and fine, is obtained from the beach and is crushed, washed, and screened.

The major construction project at the camp located in Whitnall Park consists of grading for a lake, having a water surface of 15 acres and involving the excavation of some 120,000 cu yd of earth. In addition, park and parkway drives are being graded and surfaced with gravel, three small lagoons have been dug, three stone-faced dams at the lagoon overflows have been constructed, and two stone-faced bridges on the park drive have been built. At the Root River Parkway in this park the channel of the river was lowered and widened, and the side slopes were flattened to relieve the periodic flooding of the stream.

Honey Creek Parkway, located in a valley in the heart of one of Milwaukee's exclusive residential suburbs, involved other CCC work. After years of effort this property was acquired in 1931 by condemnation and by assessing the cost of the land acquired against the district benefited. The relatively narrow parkway strip made essential numerous changes in the major channel in order to confine the creek within the limits of the parkway. Thus it was necessary to construct revetment walls at the sharper changes in channel direction. To fit the topography and provide suitable frontages for land subdivision purposes, it was found essential to cross the creek four times with the parkway drive. These requisite bridges as well as two others within the parkway area were built of reinforced concrete with limestone facing.

CONSTRUCTION OF REVETMENT WALL ALONG MENOMONEE RIVER PARKWAY

Construction operations at the camp in Estabrook Park are of an entirely different character from the others described. This camp is continuing work started as a CWA and FERA project. It is a flood control project, which consists in the removal of approximately 100,000 cu yd of solid limestone rock from the bed of the Milwaukee River. Severe floods on this river, culminating in a major disaster in 1924, prompted the city engineer of Milwaukee to make a thorough study of conditions, with a view toward elimination of the causes of floods. The removal of a rock barrier was one of the remedies suggested for partial elimination of these causes. This work is now under way as a joint project of the city of Milwaukee and the county, the latter functioning through the National Park Service in Estabrook Park. It has been one of the most gratifying of the relief projects. To facilitate the work, a crushing and screening plant with bins has been erected. The harder rock, as shown by crushing tests, is being used for concrete aggregate in the construction of many of the structures previously mentioned, while the less durable material is used as a base in the construction of drives and parking stations.

This résumé of emergency work performed in the Milwaukee County system of parks and parkways is indicative of the extent to which relief labor may be employed where there are proper facilities for planning its performance and for guiding and directing its activities. The Milwaukee County Regional Planning Department, partially responsible for the accomplishments described, has on its executive staff E. A. Howard, supervising engineer; Ray E. Behrens, senior assistant civil engineer; and A. L. Boerner, landscape architect.

Sanitary Engineering Committees Report

Variety of Work Described at Two Division Sessions on January 17, 1935

ACTIVE studies and research are being carried on by a number of committees appointed by the Sanitary Engineering Division of the Society. At the Annual Meeting a considerable part of the sessions of this Division both in the morning and afternoon of January 17, 1935, were devoted to the presentation of such reports and their discussion from the floor. These reports will be given in condensed form in the order in which they were discussed.

Committee on Salvage of Sewage

IN THE ABSENCE of A. M. Rawn, M. Am. Soc. C.E., a brief account of the work of the Committee on Salvage of Sewage was given by Chairman C. G. Hyde, M. Am. Soc. C.E., who remarked at the outset that this subject perhaps does not interest those in the East to the same extent that it does those in the arid West. In the East it is not necessary to salvage sewage for the purpose of obtaining water, whereas in some sections of the country of course water is a very expensive and difficult thing to secure, even regardless of expense.

The committee has been working very effectively and for its assistance has gathered as a subcommittee a group of very distinguished men in various fields. As a whole its work has been subdivided into nine different stages of the problem. Of its most recent work, Chairman Rawn reports: "The activities of the Committee on Salvage of Sewage, for the period July to December 1934, have been limited to obtaining data upon the re-use of waste water discharged into flowing streams, the character of water required for continuous application to the soil, and generally the extent to which sewage so regained is used in this country."

On the subcommittee mentioned, one of the members is an associate agronomist of the Department of Agriculture at the laboratory at Riverside, Calif. He has been able to bring to the committee an immense amount of material with respect to the composition of waters which may be applied to land under cultivation for various types of crops.

Another member of the subcommittee, an irrigation expert of the U. S. Department of Agriculture, is personally visiting most of the places in the United States where sewage is being used for the irrigation of crops. At the present time 121 cities and towns are covered in this survey, which is confined exclusively to the western states. A more complete report of the Committee on Salvage of Sewage is anticipated for January 1936.

Committee on Sludge Digestion

SPEAKING for the Committee on Sludge Digestion, Chairman Samuel A. Greeley, M. Am. Soc. C.E., stated that his committee's report had been completed and was in the process of revision for publication. It was hoped and expected, he reported, that the final adjustments would be made shortly and that the report itself might be published by the Society.

Committee on the Promotion of the Status of Sanitary Engineering

REPORT of the Committee on the Promotion of the Status of Sanitary Engineering was presented by Chairman Hyde, who commented that it is a matter of extreme interest to sanitary engineers to realize that in important conventions of various authorities in dealing with public health matters in Washington the engineer has not been present. Such a situation must not continue, he felt. If the sanitary engineer is to take his place in environment control and in preventive medicine, to which he has lent himself in such distinguished fashion, it must be understood by those in authority that he must not be neglected. This committee proposed to do what it can to advance the interest of sanitary engineering in these fields, as well as in those fields which have long been recognized as particularly belonging to this phase of engineering.

For example, one inquiry has been made as to the service of sanitary engineering in the public health field—not Federal, but applying to state, county, and city work. As a result of such inquiries, it is hoped later to present valuable conclusions and recommendations.

This committee has consisted during the year 1934 of the Executive Committee of the Division, with the addition of Thorndike Saville, M. Am. Soc. C.E. For the coming year, H. E. Miller, M. Am. Soc. C.E., who has devoted particular attention to this problem, has been asked to serve as chairman of this special committee.

Committee on Filtering Materials

In introducing the report of the Committee on Filtering Materials, the chairman of the meeting remarked that this committee had been working since 1925 and had done very distinguished work. The chairman of the committee, W. E. Stanley, Assoc. M. Am. Soc. C.E., then responded and described the general status of the work.

Two reports, one on fine-grained materials for sewage and the other on trickling filter materials, are now in process of being edited and worked into a publishable form so that the results can be made available to engineers in general. This committee was set up primarily at first to deal with sewage trickling materials. In this field there are still problems which have not as yet proved susceptible to definite conclusions for the reason that the problem is beyond available information.

The question of the type of material to be used in a trickling filter is related to the matter of whether slag, stone, or other material is to be used. It is also a problem related to the loading and efficiencies of the different filters. A vast amount of material has been collected in this study, and the real problem is to work this information into a form that can be given out and made available for the benefit of other researchers.

The committee has tentatively planned to issue its report in the form of two subdivisions, subject to review and modification. In general, its idea is to include in Part 1 a rather general statement and in Part 2 the results of the valuable researches by James W. Armstrong, M. Am. Soc. C.E., of the committee, and others. Through Mr. Armstrong's painstaking work, 16 different cooperating agencies—water filtration plants—have been drawn in to work on the problem. These experimental studies started in 1926.

As an example of the thoroughness of this work, it took 12 months to run 12 sets of tests, and a great many thousand measurements and weighings were required.

As a result, the committee believes that it has reached a definite basis of knowledge as to what effect the size of the sand has on the operation of a filter.

FILTERING MATERIALS—SANDS FOR WATER FILTERS SPECIALLY STUDIED

Following Mr. Stanley's general comments, Mr. Armstrong presented in some detail an abstract of his committee's work, illustrating a great many technical features by the use of slides, which he described at some length. Presumably, he observed, every structural and designing engineer has frequently worked for a long time over some problem without coming to any satisfactory conclusion and then, perhaps suddenly, has discovered the obvious thing and wondered why he did not think of that at the very beginning. Likewise, he remarked, the committee has worked from the complex towards the simple.

First, those who were cooperating in the experiments had to learn to speak the same language, and in order to do this it was necessary to define certain words. For instance, a clear water is defined as one in which the turbidity does not exceed 0.02 ppm. One of the basic ideas established was that all water used in the experiments must be properly treated. The committee's definition of a properly treated water was one which contains no colloidal turbidity. The term "critical depth" was used to designate the maximum depth that silt will penetrate into a bed of uniformly graded sand up to a loss of head of 8 ft when the filter is delivering a clear effluent.

One of the greatest difficulties encountered in the earlier part of the work was to develop a technique for carrying on the experiments. It was only after a lapse of considerable time, much correspondence, and a number of conferences, that a procedure was finally agreed upon that would enable the various cooperators to be sure that the work in the different cities was carried on in the same way.

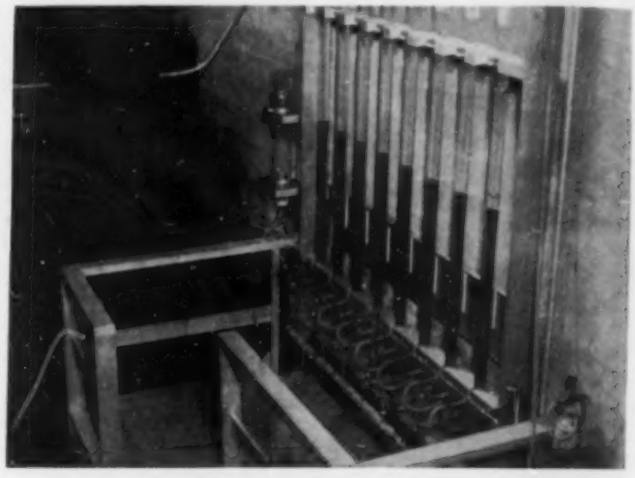
The experiments conducted in 1933 were carried on with eight filters, each containing 24 in. of graded sand. The first filter was equipped with 10 different grades of sand, each 0.2 ft in depth. In the second filter, the finest size was omitted and the tube was filled with 9 layers of equal depth. In each succeeding filter the finest size was omitted, until in the last filter there were but 3 different sizes, each 8 in. in depth.

A simple method was devised for determining the efficiency of a filter wash. This was divided into two parts, primary and secondary. The primary wash is considered as that ordinarily performed in a filter plant, and the secondary wash consists of the washing out of all the sediment that remains in the filter after the primary wash is completed. The efficiency of a filter wash is the percentage of total sediment deposited in the sand during a filter run that is removed in the primary wash. Of course the efficiency of a filter wash could not be determined on a large-sized unit.

In 1934 a series of experiments was conducted on sand of uniform size. Eight different units were equipped, each with uniform but different grades and depths of sand. By conducting this series of experiments, the critical depth of each grade of sand was determined. Sufficient basic knowledge was thus gained to determine the proper depth of a filter bed, if a sieve analysis and the critical depth of each grade of the sand under consideration are known. It appears to be possible to get a good filter effluent from any grade of sand, provided the filter bed is deep enough. Another interesting discovery is that apparently the critical depth of sand varies as the square of the average diameter of the sand grains. All the tabulations roughly bore out this conclusion.

Mr. Armstrong thinks that the experiments point rather definitely to certain conclusions, but as the committee has not had an opportunity of passing on them, he preferred to present them simply as his own opinion.

The depth of a filter bed should be increased as the sand size increases. The hours of service and the efficiency of the wash increase as the sand size increases. The rate of applying wash water should be increased as the sand size of the filter bed, and the temperature of the water, increases. With the coarser sands, the water should be applied at a rate higher than that generally used, but if wash water is applied at too high a rate, the efficiency of the wash is decreased. With fine sand, the wash is inefficient and the hours of service are very few. With very coarse sand, a high washing efficiency and long hours of service can be secured if the bed is of proper depth, but a rate of wash higher than that ordinarily used is necessary for proper cleaning of the filters.



EXPERIMENTAL FILTERS, KANSAS CITY (MO.) WATER DEPARTMENT

In many places it is impractical to get an ideal sand without a cost out of all proportion to the benefit gained. In such cases it might be better to use a local sand, which if necessary can be supplemented by adding a small amount of a high-priced sand of the proper size. It is the function of the engineer to decide as to the best solution of such problems.

The subject matter covered by Mr. Stanley and by Mr. Armstrong is to be presented in its complete form to the Society for publication. If such publication proves feasible, members will be privileged to study in more valuable detail this excellent work on filter materials.

COMMITTEE ON WATER SUPPLY ENGINEERING

For the third successive year the Committee on Water Supply Engineering reported, through its chairman, Thomas H. Wiggin, M. Am. Soc. C.E. He explained that the committee has come to see its function as that of visualizing the progress in water supply engineering through the previous year. With this in mind, the committee gave a complete and valuable report covering 1934.

A consolidated report for the years 1932 and 1933 was printed in the December 1934 PROCEEDINGS, pages 1463 to 1484. Likewise, the 1934 report of the Committee on Water Supply Engineering is expected to appear in PROCEEDINGS during the spring of 1935.

Spray Drying of Sewage Sludge

Abstract of Paper Presented Before Sanitary Engineering Division on January 17, 1935

By CHAMPLAIN L. RILEY

VICE-PRESIDENT AND TREASURER, INDUSTRIAL ASSOCIATES, INC., NEW YORK, N.Y.

THE problem of disposing of sewage is a problem in dewatering. If sewage containing one hundred parts per million of suspended solids is concentrated by sedimentation and digestion to a sludge containing 10 per cent solids, about 999 parts of water out of every 1,000 have been removed. The disposing of the last one-thousandth part of the water and the reclaiming of the dry solids in useful form is the problem under consideration here.

In the process of spray drying the sludge is pumped into a centrifugal spraying machine in the top center of a large drying chamber. This machine atomizes the sludge and sprays it out horizontally and it dries as it falls to the floor. The flue gases from a furnace pass downward through the drying chamber and are afterward circulated by a blower through a dust collector and back into the upper part of the stack. From the floor of the drying chamber the sludge is gathered into a hopper by a revolving rake, and from the hopper it is removed by screw conveyor or otherwise.

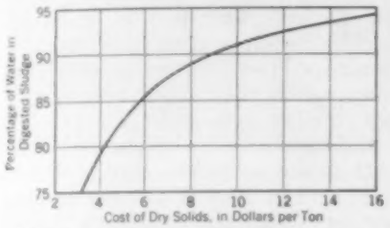


FIG. 1. COST OF DRYING DIGESTED SEWAGE SLUDGE

Spray drying has been practiced for many years, principally for milk. The spray drying of muds and slurries was not generally practiced until a reliable centrifugal spray machine was developed. The work leading to this development was begun in 1922 and resulted in the type of machine now in use at the Plainfield, N.J., sewage disposal works. The type of high-temperature spray dryer now being used for sewage sludge is inexpensive compared with most other types of drying equipment and is economical in the use of fuel. Since the product of spray drying is in powdered form it is easily processed for the market, or it may be consumed as fuel on the premises, as in the case of sewage sludge.

If water is atomized in a spray wheel running at between 9,000 and 10,000 rpm and if the particles of mist are assumed to be approximate spheres 0.001 in. in diameter, then in a gallon of water there will be about 44 billion such spheres, and their total surface will be 138,500 sq ft, or more than three acres. This enormous surface presented by each gallon of liquid ensures instantaneous evaporation.

Particles smaller than 0.1 mm in diameter falling through air soon reach a velocity which remains constant. This fact is expressed by Stokes' law, which is that the velocity is proportional to the surface area of the droplet, or to the square of its diameter. Minute droplets settle slowly and evaporate almost immediately, whereas large ones settle rapidly and without appreciable loss by evaporation. A raindrop 2 mm in diameter can fall miles without completely evaporating under conditions that would cause a 0.2-mm droplet to disappear before it had fallen the height of a man.

The capacity of the dryer, disregarding losses due to radiation and air infiltration, is proportional to the drop in air temperature due to evaporation in the drying chamber. Assuming that a spray dryer operates at an initial temperature of 800 F and sprays 80 lb (about 10 gal) per min of sludge, then the cost of drying sludge containing 90 per cent of water is approximately $8.92 per ton of dry solids, and about 8.3 lb of water are evaporated per pound of coal. If the dried product is burned to provide heat for drying, the cost of drying becomes about $7.21 per ton. The estimated cost of spray drying of digested sewage sludge is shown in Fig. 1.

Since the cost depends directly on the degree of preliminary concentration, it is important to consider all possible means of concentrating the digested sludge. There are at least four methods of accomplishing this: settling, flotation, centrifugalization, and filtration.

Very few data are available on the subject of thickening digested sludge by settling. Under favorable conditions, with a 90-day detention period, the solids content may be raised to 10 per cent by this method.

Solids in digested sludge may be floated to the surface and much of the water drawn off as underflow, by the addition of a coagulant that forms a gas, which is caught in the floc and floats it. By this means the water content can be decreased to about 90 per cent.

The centrifugal separator now in use at the disposal plant at Collingswood, N.J., produces a cake of about 55 per cent moisture when operating on digested sludge, but the consumption of power is considerable.

If filtration is used as a step preliminary to spray drying, the cake to be produced need not be the dryest possible. A low over-all cost for filtration and spray drying together can best be obtained by running the filter rapidly, and producing a cake containing from 75 to 80 per cent of moisture, instead of one containing from 68 to 70 per cent, which may be obtained with slower speeds. The total operating cost of filtering and drying together, per ton of dry solids, is about the same as that for spray drying alone of a sludge of 90 per cent water.

In estimating the cost of sludge drying, no credit has been allowed for the use of the dried product. It is thought that this can be sold for fertilizer, but the price that can be obtained is so uncertain that it is best to consider it only as fuel. Samples tested show about 6,000 Btu per lb, or three-sevenths of the value of coal.

If any conclusions may be drawn from an experience that has extended over a few months only, they are the following. Digested sewage sludge can be spray-dried without difficulty. The problems presented to the engineer are economic and not technical. For communities up to 100,000 in population, a single spray chamber will suffice if the digested sludge is concentrated to a solids content of 10 per cent. This may be done by flotation or settling without a filter. To secure economical results for communities of over 100,000, the sludge should be concentrated by filtering to a solids content of between 20 and 25 per cent before spray drying. It is believed that both the filter and the spray dryer will be operating under optimum conditions if used together.

Function of State Planning Boards

A Discussion of Their Relationship to Regional, County, and City Planning Agencies

DURING the past year and a half—largely through the efforts of the National Planning Board and its successor, the National Resources Board—more than 40 state planning boards have been established to assist in the formulation of special programs to be followed in expending funds made available through the Public Works Administration and the Federal Emergency Relief Administration. The idea is new and many new problems have been presented in putting it in practice. At the session of the City Planning Division on January 17, 1935, held in New York during the Annual Meeting of the Society, a round-table discussion brought out various phases of the problem. One result was the adoption of a resolution authorizing the appointment of a committee of the Division to take up with the Federal Emergency Relief Administration the need of obtaining a more definite authorization and procedure in city, county, and regional planning surveys and studies as part of any emergency work program. Abstracts of several of the discussions follow.

State Commission's Function of Leadership

By JOHN NOLEN, JR.

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WASHINGTON, D.C.

IN considering the relation between state planning boards and local planning boards, there is one fundamental point that should be borne in mind. Since the authority for local government comes from the state, the state planning board is in a strategic position to lead, to guide, to coordinate, and to stimulate the work of the local boards, but in no case should it do the work that is essentially theirs. Planning by local jurisdictions is exceedingly limited in that the urbanized areas they control are usually separated by intervening areas much less intensively developed. The purpose of the state board should be to correlate the planning of these more highly developed areas in relation to one another, to the state as a whole, and even to adjoining states.

The state has certain functions related to planning which the local governments do not have. Examples of these are conservation and the development of natural resources, which are now being given a great deal of attention by the Federal Government through the National Resources Board as well as by the states. The comprehensive plan and program recently submitted by the National Resources Board to the President has been transmitted by him to Congress with high commendation. For all these reasons state planning boards are a logical part of state governments and are needed to ensure the success of local planning and the coordination of these efforts on a broad national basis.

Principles of Coordination

By HAROLD M. LEWIS

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FOUR principles may be considered as basic in the establishment of an adequate relationship between the various types of planning. The first is that the intensity of the study made by the planning agency should vary with the size of the area. The second is that the larger the area, the more advisory should be the features of the plan, and also the more diagrammatic they should be. The third is that local jurisdiction and machinery should be used where possible in administering planning. However, an exception to this third rule should be made in the case of those municipalities which are very small in area and are too closely related to adjoining municipalities to be planned independently. Places of this kind are to be found in Nassau County on Long Island and in Bergen County in New Jersey, where there are very small and irregularly shaped municipalities having boundaries located without rhyme or reason when considered from the planning point of view. The fourth principle is that where local jurisdiction will not act, the larger jurisdiction should be empowered to do so. Here also the word "local" should be qualified as in the statement of the third principle.

A discussion of the application of these four principles will indicate whether or not they are reasonable. Of course in many features of the plan there may be overlapping jurisdictions. This is particularly true in the case of highways, where there are not only local, county,

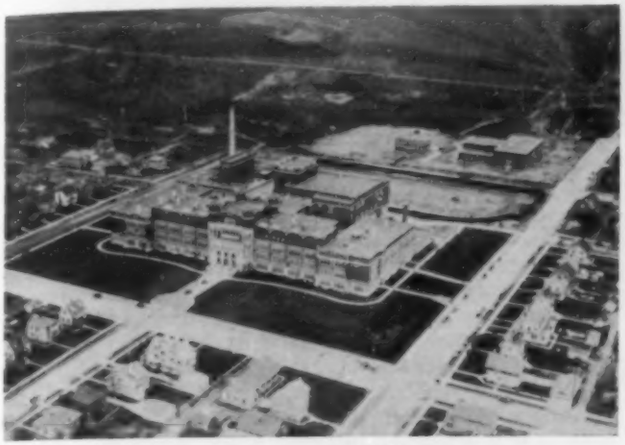
CITY AND HARBOR, DULUTH, MINN.

state, and national routes, but also federal-aid, state-aid, and in some cases even county-aid highways. Complications also arise in the matter of transportation lines for passengers and freight, in that interstate commerce comes under Federal jurisdiction through the Interstate Commerce Commission.

A good basis for dealing with these complications is presented by the recently published results of a research conducted by Harvard University, resulting in two different sets of model enabling acts for local, state, and county planning. One set was prepared by Edward M. Bassett in collaboration with Frank B. Williams, and the other by Alfred Bettman. These have been presented with the explanation that they will not be universally

adaptable and must be applied only after a careful study of local conditions.

There are some important differences in the methods of legislation suggested in these two sets of laws. For example, in the Bassett–Williams plan the county planning board controls only county facilities, while in the Bettman plan it is authorized to plan for all types of facilities, both county and municipal, so far as the master plan is concerned. Mr. Bettman suggests that there be separate acts for county master planning, for county



HIBBING HIGH SCHOOL ON THE IRON RANGE

zoning, for the regulation of subdivisions, and for maintaining the integrity of mapped streets. That is, he suggests the adoption of four different county acts to control planning, while Mr. Bassett and Mr. Williams suggest only one and do not believe in giving a county control over zoning and platting.

Considering the problem of maintaining the integrity of mapped streets by excluding buildings from them, in the light of the four principles previously laid down, the following procedure would seem logical. The state planning board would prepare a master plan of state highways as a part of the complete master plan and would certify to the county officials a copy of this highway plan as it applied to the county and ask them to include such a system of highways in their plan. Then the county planning board would work out a more detailed system of master-planned highways, including state highways, and would certify its adopted system of highways to the municipal officials and ask them to include it in the local official map. Of course this would not affect the final jurisdiction of the state highway department over the state highways. The next step would be for the municipality, with the aid of its municipal planning board, to draft an official municipal map to include state, county, and local highways.

Under this procedure, the exclusion of buildings from the beds of mapped streets would be handled by the machinery of the municipality, and the local board of appeals would be available for the adjustment of inequitable situations. As provided in both the Bassett–Williams and Bettman acts, it might be required that permits for building in the beds of mapped streets should be obtained from the county planning board if within a reasonable time the municipality did not prepare an official map showing county and state highways.

If this procedure is applied to the detailed location and design of highways, it works out as follows. First, the capacity and general character of a main highway—one of more than local importance—would be determined by the state or county board, depending upon its relative importance, rather than by the municipality. Second, the actual location of such a highway would be determined locally—this to include such details as the number of feet to be taken off each side of a street to be widened. The municipality should have an opportunity to recommend changes in minor details, since a state or county agency determines such matters more diagrammatically and with less minute knowledge of actual conditions. Third, permits for temporary buildings in the bed of mapped streets would be issued by a local board of appeals, which could determine such matters very much more satisfactorily than could such a county-wide agency as is suggested in the standard enabling acts.

Thus the smaller the jurisdiction of the planning board, the more refined and more complete would be its work. Again exception must be made in the case of some municipalities which are entirely too small for planning purposes, and which should be planned in groups. Also, the municipality would handle the control over private property unless by its failure to act it passed such control over to a larger jurisdiction.

Stimulation of Local Planning

By M. W. TORKELSON

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DIRECTOR OF REGIONAL PLANNING, STATE REGIONAL PLANNING COMMITTEE, MADISON, WIS.

SINCE state planning boards are new, the eventual scope of their duties can scarcely be foretold at this time. In the beginning at least, their principal functions will be of a fact-finding and coordinating nature. Their additional function will be to supply the basic data which cannot be secured through other organizations, that is, information regarding the activities of the other state departments and of local organizations, both governmental and otherwise. When complete data have been assembled and coordinated, the state board should announce its findings and recommendations.

Wisconsin may perhaps be considered typical of American states. Its state planning body has an assured legal status but lacks the resources necessary for continued and efficient operation. The law provides for a park board in each county, but only a few have been created and of these not many are active. Only 35 out of several hundred cities and villages have municipal planning bodies, and some of these 35 are dormant. An early duty of the state planning board will be to stimulate local interest in planning, with a view to bringing about the creation of statutory planning bodies where they do not actually exist, and of keeping them active once they have been organized.

In the early stages, the most fruitful activity of state planning boards will be to investigate the activities of other state departments. There are several of great importance in every state, each working in its own field, and all doing good work. The activities of government are so complex, however, that it is not unusual for the right hand to be unaware of what the left hand is doing. The result is that there are duplications in some fields, while in others necessary if not urgent work remains undone. This condition sometimes exists even within departments. In general, each department is so busy with its immediate daily duties that it does not have time for much else. The state planning board, in the comprehensive survey of state affairs that it must make,

cannot fail to discover such conditions. Also, it will be in a position to point them out and assist in providing the remedies.

Thus the state planning board will become a clearing house of information. In so far as possible, it should also act as a catalyst, taking part in the reaction required to create new values, yet emerging with its identity unaffected. It should not attempt to take over any activities which are, or which reasonably might become

BIRD'S-EYE VIEW OF ST. PAUL, MINN.
Sketch of Group Plan by Cass Gilbert, Architect

the duties of other departments, for by so doing it will be creating the very duplications it seeks to avoid. It should cooperate with the other state departments and with local bodies in the performance of their respective duties within their own fields. To do this requires great tact and endless patience. The people must work out their own salvation; it cannot be worked out for them, and they would not accept it if it were handed over ready-made.

Although state planning boards are new, state planning itself is as old as state government, for government is planning. What state planning boards ought to do is to provide the means by which the people can do consciously, effectively, and purposefully what they have always been doing poorly and without aim or direction.

State Planning Boards and Their Relation to Other Planning Agencies

By GEORGE H. HERROLD

MEMBER AMERICAN SOCIETY OF CIVIL ENGINEERS
MANAGING DIRECTOR AND ENGINEER, THE CITY PLANNING BOARD, ST. PAUL, MINN.

STATE planning has been a subject for discussion during the last few years among technicians, but possibly not more than three states had given serious thought to inaugurating such a program prior to 1933. The establishment of the National Planning Board in that year; the setting up of certain governmental requirements in connection with PWA projects as to their being a part of a plan; the requirements of the Home Owners Loan Corporation that the zoning of each piece of property on which a loan was to be made should be noted as a part of the records as well as its relation to other zones; and the turning down of many PWA projects because they were not a part of a general plan or correlated in any way with a program of other improvements, have made the country planning conscious.

The request of the National Planning Board that state planning boards be set up was a natural corollary, and the establishment of 43 of these boards has followed within a year. This is a phenomenal movement, which will distinguish the present era as the beginning of more comprehensive and sound planning.

Creation of state planning boards throughout the United States has interested a new group of people in the social and economic value of planning. In the majority of instances, departmental heads such as commissioners of highways, railroad and warehouse commissioners, directors of state departments of health, directors of state departments of conservation, and heads of state universities have been drawn upon for membership. To these have been added leading citizens throughout the state whose contacts with state activities will interest them in government. A perusal of a number of the reports of state planning boards indicates that the larger part of the work has consisted in compiling an inventory, and this in itself has been a worth-while job. It is hoped that the movement is not a "flash in the pan," or purely inflationary, or an attempt to fall into line with new movements, but that it will result in constructive planning progress.

One of the problems to be worked out gradually and carefully is the relation of these state planning boards to regional, county, and city planning. It is apparent that any local planning, such as that for a city or a county, is not complete if it does not fit into a plan for the adjoining territory, and a state planning board can bring about such necessary correlation. Its major work will be in the development of a trunk highway system; the creation of freeways, tourways and parkways, state parks, and recreation areas; the planning of state civic centers; the grouping of institutional buildings in large park-like areas; the zoning of the use of lands; the retention or acquisition for public use of lands adapted for that purpose; and keeping an inventory up to date. It will of course make a state master plan, the existence of which when known to all, will give proper direction to the growth of all smaller governmental units. The state planning board may be of value also in recommending legislation that is needed to aid local planning units.

Lands would be zoned with a view to eliminating from settlement those subject to erosion or better adapted for such purposes as forestry and bird sanctuaries than for cultivation. A definite policy would be set up as to roadside developments and grade separations of main highways; as to the public's right to the shore line of lakes; and as to the collecting and recording of all surveys at some central point, where the notes and data might be available to all.

State planning is important enough to call for a full-time membership devoting all its time to the planning of the state and to inventories. The state planning board may determine the surveys, statistical studies, and research work to be done and assign these to the planning units best qualified to do the work. City planning and county planning are simply the planning of smaller units of the state, in which the local groups should have the most to say and in which they can do the best work, the state planning board exercising a guiding hand to produce the greatest correlation possible and to supply needed material.

Sewage Treatment by Modern Chemical Methods

Current Design Practices, Plant Operating Experiences, and Shortcomings, Advantages, and Trends

A GENERATION ago the chemical treatment of sewage passed from favor because of the high cost of the chemicals required and the development of the cheaper biological method. The latter, however, requires a large and isolated area for its facilities. As cities grow in extent and density, proper sites are often difficult to find, and it becomes desirable to locate a plant in a public park, as was done at Dearborn, Mich., or in an exclusive residential area, as at Birmingham, Ala. Then, too, chemicals are now more reasonable in cost, and the growing volume of trade wastes makes it advantageous to employ a method less easily upset by intermittent concentrations of such wastes than is the delicately balanced activated sludge process.

Current experience in Alabama, Michigan, and California seems to indicate that chemical precipitation may be used economically to supplement primary treatment or, as at Plainfield, N.J., to assist secondary biological treatment. Further economy results from the possibility of stopping the application of the chemicals entirely or of adjusting the amount according to the ability of the stream to handle the effluent. The chemical dosage is easily increased coincident with the daily or seasonal arrival of concentrated sewage; or it may be discontinued entirely during periods when the sewage is weak.

This symposium includes in somewhat shortened form the paper read by Mr. Enslow before the Sanitary Engineering Division on January 17, 1935, at the Annual Meeting, and the contributions of four others invited to discuss.

Chemical Precipitation Processes

By LINN H. ENSLOW

ASSOCIATE MEMBER AMERICAN SOCIETY OF CIVIL ENGINEERS
EDITOR OF *Water Works and Sewerage*, New York, N.Y.

DURING the past three years there has been a revival of chemical treatment of sewage by modernized chemical-mechanical methods. The past two years might be considered as a period of "watchful waiting" for developments and an evaluation of accomplishments of chemical processes on the part of sanitary engineers. Today there are 50 or more American plants completed, under construction, or definitely planned, in which chemical precipitation alone or in combination with biological processes is being, or will be, employed. In addition, there are not less than 14 such plants proposed, 12 to employ chemical treatment alone and 2 to use it for assisting biological processes.

In view of these developments since the completion of the first of the modern plants—that at Dearborn, Mich.—it seems proper to review the reasons for the revival of chemical processes, to weigh their advantages and shortcomings as employed today, and to look into their probable future.

An analysis of the reasons for the revival of chemical processes in sewage treatment shows that the outstanding one is that they fill the gap between sedimentation on the one hand, and the activated sludge process and the sprinkling filter on the other. Sedimentation, while simple and inexpensive, removes a comparatively low percentage of the solids and organic content of the sewage. The activated sludge process, which is highly efficient in this regard, is complex and expensive; and the sprinkling filter entails a large capital investment and considerable land area and is frequently attended by odor and insect nuisances.

The need for a process capable of producing an effluent of pleasing appearance similar to that from a properly functioning activated sludge plant, with perhaps a somewhat less complete removal of organic matter but at a lower cost, was and is the desideratum. The need has been felt for a controllable process less disastrously affected by sudden discharges of industrial waste than is the activated sludge process. The availability of modern mechanical equipment; of chemical feeding devices; of varied, improved, and less costly coagulants; and of more precise and better understood methods of control have, collectively, placed chemical treatment on a far more inviting basis than it was in the last century, when it was found less attractive on practical grounds and also more expensive than the biological processes of that day.

Added to these reasons for revived interest in chemical treatment is another and important consideration—its desirability, due to low first cost for plant and equipment for seasonal use. Although the operating cost may be higher while it is employed, the average over-all cost is less than that of providing biological treatment for similar seasonal use.

COST AND FLEXIBILITY ARE PRIMARY ASSETS

Possibly the chief point in favor of chemical treatment is the fact that plants to provide it are less costly to build than plants for biological treatment and less expensive to operate, considering that the application of chemicals may be discontinued for long, short, or seasonal periods, as determined by the condition of the water course into which the effluent is discharged. During periods of 6 to 8 hr of each day, usually the sewage reaching treatment plants needs nothing more than sedimentation to produce an effluent that will be acceptable under the most exacting standards. It is apparent therefore that a small investment in structures, equip-

ment, and stocks of chemicals, and ability to make treatment more or less complete on short notice, as desired, both appeal strongly to the sewage treatment economist.

Flexibility of purification efficiencies attainable through mechanical-chemical methods is also alluring. If by ordinary sedimentation a degree of purification of 35 to 40 per cent is attainable, then by adding chlorination to further reduce the oxygen demand, a degree of purification up to 55 or 60 per cent—possibly 65 per cent—can be secured. Further, by a combination of coagulation and sedimentation a degree between 65 and 75 per cent can be attained with certainty. Proceeding still further, a degree of purification as high as 80 or 85 per cent can be had, when a combination of chemical precipitation and chlorination is employed.

LABORATORY TESTS FAIL TO GIVE TRUE PICTURE

An important distinction should be made between the apparent purification efficiencies of chemical processes, as measured in laboratory bottles, for the 5-day oxygen demand test, and the actual comparative benefits to be noted in stream improvement. For example, as noted by actual observation, the 35 per cent degree of purification indicated by laboratory findings as being creditable to sedimentation is in truth far more valuable in obtaining stream improvement than this figure would indicate. It must be given a far greater weight in the final analysis than the next increment of 35 per cent of purification, by whatever method it is secured, which involves the removal of non-settleable and slowly settleable materials, which also form sludge and scum. This fact becomes evident when it is considered that the most important elements in creating nuisances in streams are the sludge- and slime-producing substances, which can be removed almost completely by simple sedimentation and which when not removed result in cumulative and localized bottom and marginal conditions.

Settled sewages also carry colloidal and pseudo-colloidal solids, which are deposited on contact surfaces in streams to produce unsightly and cumulative slime masses mixed with filamentous biological growths. In saline or brackish waters the pseudo-colloids become "salted out" and precipitate to produce sludge deposits. It should be noted that chemical precipitation leaves nothing in the effluent capable of producing cumulative effects from after-precipitation or colloid adsorption by contact surfaces in the water course. Therefore when the oxygen-demand test reveals an added improvement of 35 per cent as the result of chemical precipitation, there is justification for considering the true effect, which may be realized in terms of actual stream improvement, to be greater than the laboratory picture would indicate. Weighing performances thus, and considering the markedly improved appearance of the effluents attained by chemical precipitation, the true potential advantages of such treatment become evident.

Processes that are capable of coping with industrial wastes, either alone or when added to domestic sewage, are daily assuming greater importance. Authorities are being increasingly confronted with the problem of disposal of such wastes through the municipal sewer systems. Chemicals toxic to the activated sludge process and non-uniform organic loadings, which overtax and upset biological processes, require a new type of treatment planning for the future. To demand that industry keep its wastes out of municipal sewers or apply partial treatment to them before they are discharged into the sewers may be theoretically advisable, but in actual practice it seems difficult of attainment. It would appear therefore that a possible practical solution to this problem is offered by chemical treatment—either alone or preliminary to secondary biological processes, if not continuously, then during the hours of heaviest industrial loading.

Controllability in handling sewage of variable quality and volume is among the advantages of chemical processes. Although the control of such processes is not as simple as some would have us believe, nevertheless deficiencies in treatment are more readily and quickly ascertained and adjusted, to procure effective results, than is possible with biological processes that have suffered an upset.

About 12 processes of chemical precipitation are available, and of these 4 seem to be sufficiently important and basically sound to warrant attention. No attempt will be made to analyze the various processes, inasmuch as all those worthy of serious consideration—with the exception of the more complicated Guggenheim process—will yield practically identical results in degree of purification attained, that is, a reduction in oxygen demand of between 70 and 80 per cent. The Guggenheim process involves removal of soluble saline and albuminoidal ammonia compounds by passing the clarified effluent through zeolite beds, and results in efficiencies equal to those of the activated sludge process, or actually exceeding them at times.

CHOICE OF COAGULANT AND PROCESS

For coagulation there are still available, as of old, the simple ferrous sulfate and lime. To efficiently employ this combination on most sewages, appreciable aeration is required as well as a pH value of 8.4 and higher. Among the modern coagulants there is ferric chloride, available in liquid, lump, or anhydrous form; the new anhydrous ferric sulfates; and chlorinated (oxidized) ferrous sulfate, known as "chlorinated copperas," which is produced as used by merging the chlorinator discharge solution with the copperas solution as it leaves the dry-feed machines. Another method of procuring ferrous or ferric chloride employs a tower filled with scrap iron, through which chlorine water flows slowly upward. The ferrous chloride may be used as such or may be converted to ferric chloride by further chlorination of the tower effluent. Chlorinated ferrous sulfate for the present appears to be the most economical ferric coagulant. In the final analysis, selection of the coagulant should hinge on the question of what materials or process will yield the greatest weight of ferric iron at the least expense. In chemical precipitation, all ferric salts are about equally effective on the basis of the iron involved. However, this is not so with sludge dewatering on the acid side of neutrality. In this case ferric chloride remains superior to all other ferric salts.

In making a selection from the chemical processes available, each must be considered on its individual merits, with local conditions in mind. The same applies in the selection of a coagulant because economics is the basic consideration. The avoidance of complicated processes, involving a number of chemicals, or those producing heavy sludge deposits, is warranted. There appears no practical justification for the use of anything more than the most inexpensive ferric salt and pH adjustment—if required—with a minimum of acid or lime to procure the most efficient coagulation with the least sludge production. In some instances the addition of acid to cheapen or assist coagulation will be found more effective and economical than lime. In chemical precipitation, the simpler the process, the more practical and economical it becomes.

In the use of iron salts, one matter of first consequence

in performance and chemical costs is that of rapid and efficient flash mixing followed by slow-motion flocculation for periods of 10 min and more. To preclude reduction of the iron in ferric salts and avoid indifferent coagulation, air blowing or pre-chlorination to oxidize reducing compounds in the sewage is almost essential in warm weather.

The value of pre-settling prior to coagulation has been effectively demonstrated, first, by Stevenson at Palo Alto, Calif., and on a larger scale by Hendon at Birmingham, Ala. A further and decided gain is made by withdrawing the chemical sludge from the secondary tank frequently if not continuously, and delivery into the crude sewage. Economy is attained by reduction in the amount of chemicals required, and there is also the highly practical advantage of consolidation of the dilute chemical sludge with the crude sludge in the primary tank, whence the thickened mixed sludges, carrying from 94 to 96 per cent of water, are pumped to digester or dewatering filters. Reduced disturbance in the digester, lessened heat loss, and improved quality of the materially reduced volume of supernatant digester liquor are likewise important advantages gained by the series operation of settling units and return of the chemical sludge to the crude sewage.

A real advantage secured from an hour of pre-settling is that variations in the quality of the sewage are minimized, especially for sewage likely to contain intermittent concentrations of industrial wastes. A sewage of far more uniform characteristics is thus delivered for coagulation. Furthermore, grease and other floatable matter will be confined to the primary unit, leaving the secondary precipitation tanks clean and sightly and precluding the need for frequent skimming. The return of chemical sludges, containing iron floc, to the crude sewage not only serves to adsorb non-settleables and drag them down but, if added as the sewage enters the plant, promptly combines with the volatile sulfides and serves as an odor corrective.

PROBLEM OF INCREASED SLUDGE PRODUCTION AND DISPOSAL

As regards the increased volume of sludge in chemical precipitation, this may or may not be an argument against the process in general. If coagulation aids are employed in sizeable quantity—such as marl, Cottrell precipitator dust, clays, or ground limestone—then the increased sludge produced becomes burdensome. The same may be said when heavy dosages of lime are added to procure alkaline coagulation. Every pound of lime added to water to soften it produces more than three times its weight of calcium carbonate sludge, and the same applies when lime is added to sewages. A combination of lime and finely divided inert or semi-inert coagulation aids is therefore best avoided if sludge production is to be held at a minimum. There are but scant data on the amount of additional sludge produced by the simplest known precipitation methods involving the use of ferric salts, either alone or with as little lime as may be needed to obtain the most economical and efficient precipitation.

In actual operation Hendon, at Birmingham, considers that the use of chlorinated copperas (without lime) increases the sludge solids on the average by 10 per cent. The increase is computed on the basis of the dry weight of the actual solids removed from the sewage and delivered to the digesters. It is therefore apparent that the older processes, which involved large quantities of lime and did not include thickening of crude and chemical sludge, such as is practiced at Birmingham, yielded a much larger volume of sludge. Without this combination sludge thickening, the volume of unthickened chemical sludge to be delivered to the Birmingham digesters, or otherwise disposed of, has been found to be 3 to 5 times as great. Herein is one of the material advancements of modern practice in chemical treatment over that of the nineties, when tons of lime were shoveled in and then shoveled out again as unthickened sludge. No wonder that as a consequence chemical methods were relegated to the junk pile.

CLARIFIER AND UPFLOW MAGNETITE FILTER UNDER CONSTRUCTION AT PERTH AMBOY, N.J.

The Slowly Revolving Arm Carries a Magnet to Lift, for Washing, the Magnetite Filter Medium Laid on the Grating. This Chemical Sewage Treatment Plant Is Designed for 10 Mgd

When it comes to effectual disposal of chemical sludge, the combination of dewatering on vacuum filters and incineration bids fair to become the preferred method at the larger works. For the smaller plants, digestion will be favored provided the sludge is not too alkaline as the result of lime precipitation or not too heavily loaded with inert precipitation aids or toxic metallic compounds, such as would be produced by copper salts and the like. At several points incineration is being developed. At Dearborn, Mich., the Nichols-Herreshoff type of incinerator has been installed under a guarantee that it will successfully burn chemical sludge cake. At Winston Salem, N.C., incineration of the filter cake is being studied with the thought of recovering lime from the ash. Incineration of chemical sludge also constitutes a part of the Guggenheim process.

DIGESTION OF IRON-BEARING SLUDGES SUCCESSFULLY ACCOMPLISHED

For many years iron-bearing sludges have been successfully digested; such reasonable iron content as is found in mixed crude and chemical sludges may be expected to improve rather than hinder digestion, making for a more granular and more easily dewatered digested sludge. Furthermore, the moisture content of the sludge is lower, as is also the solids content of the supernatant liquor. The digester gas should be materially lower in sulfide content, which is so deadly to man and so destructive to gas burners, heaters, gas engines, and other appurtenances. More than likely the gas will be practically free of sulfide because of the capacity of the iron to combine with it, resulting in the production of non-volatile iron sulfide. At Birmingham no interference with sludge digestion has been noted. The sludge has been of good quality and has been dewatered and dried with rapidity on the beds. Further, the remarkable clarity of the supernatant liquor, containing 100 ppm of suspended solids, has been credited in large measure to the clarifying effects of the iron.

It has become evident that sewages possess varying degrees of resistance to coagulation. Some require several times the chemical dosage that others do to secure effective agglomeration of the colloidal particles. The concentrations of organic compounds and inorganic salts produce the varying degree of buffer effects which resist acid or alkali ions, productive of changes in pH value and consequent release of water from hydrophillic colloids, and induces their shrinkage and agglomeration. The souring of milk, resulting in the curdling of its colloids and eventual clarification, is an illustration of the effect procured artificially by acid added directly or in the form of ionized coagulants to organic colloids in suspension. Economy in precipitation may be secured by lowering pH values to produce a "cracking" of the dispersed colloids with inexpensive sulfuric acid and thereafter completing the job of agglomeration and weighting of floc with the more efficient but more costly metallic coagulant.

IMPORTANCE OF EFFLUENT FILTRATION

In chemical treatment filtration of the effluent deserves the same consideration that it should be given as an adjunct to the activated sludge process. Few activated sludge plants are so liberally designed as to prevent disturbance of the sludge in the final tanks during and shortly after periods of peak loadings. Also, few are free of the trouble known as sludge bulking. In both cases sludge is daily carried out with the effluent, often in appreciable volume. This condition may be corrected at considerable expense by further increasing the capacity of the final settling tank, or by raising the power input to increase aeration, or by both methods. Mechanical filtration or straining of activated sludge effluents has been successfully practiced and deserves more consideration as a means of removing suspended sludge flocs from an otherwise satisfactory effluent. Its advantages are purely economic; the painstaking and expensive attempts to maintain a sludge of high density and avoid critical velocities through tanks, to prevent sludge "leakage," may not be sound practice if the same ends can be attained more economically by straining filters.

As regards chemical precipitation, the same argument holds. At peak loading a settling period of from 60 to 90 min may prove inadequate to preclude the sweeping through of the lighter floc particles or those slow to form and settle in under-coagulated sewages. Strainers consisting of coarse-grained and high-rate shallow filters—preferably self-cleaning—offer a more practical measure of maintaining a uniform effluent than attempted adjustment of the chemical dosage to meet peak requirements, and one more economical than the provision of settling capacities sufficient to avoid critical floc-sweeping velocities under all loads. In water purification, engineers were not long in progressing from coagulation or softening with a long period of sedimentation to short-period sedimentation complemented by rapid filtration. Filtration of effluents probably will come to be an accepted practice at most sewage treatment plants on grounds of operating economy as well as enhanced efficiency and dependability.

COST OF TREATMENT

The cost of chemical treatment is a much discussed topic. Like the cost of the activated sludge process it will vary considerably with the strength of the sewage, the prices of chemicals and power, and the size of the plant. Costs have been quoted all the way from $5 to $15 per million gallons for the chemicals involved, depending on the process employed, the type of sewage treated, and the price of the chemicals. For the simplest processes, involving iron salts with or without lime in moderate dosages, the quoted figures of $5.60 to $6.50 per million gallons for chemicals seem supportable. Where several chemicals are involved, or where zeolitic treatment of the effluent is added, the cost mounts appreciably. The higher efficiency of the Guggenheim zeolitic process must, however, be taken into consideration.

At the Shades Valley Plant of Birmingham, Ala., which treats 1 mgd, the simplest of the chemical processes, involving the use of chlorinated copperas and prechlorination, has given an excellent record of performance. The chemical costs have averaged $5.40 per million gallons with copperas at $17.50 per ton and chlorine, in ton containers, at 3 cents per lb—prices that are none too reasonable. On another Birmingham sewage of three times the strength—an oxygen demand of 300 and 310 ppm of suspended solids—experimental plant operation during a period of weeks has justified the predicted chemical costs of $6.50 and total operating and fixed charges for a 12-mgd installation, costing $212,000, of $13.84 per million gallons. The latter estimate is based on continuous use of the precipitation process, involving average chemical dosages as determined.

If the chemicals are needed only 6 months in the year, their average annual cost becomes $3.25 per million gallons, which, added to the other operating and fixed charges of $7.34, gives a yearly average total of $10.60 per million gallons. This amount slides downward toward $7.34, depending on how much below 180 days per year the chemical treatment is used. The costs at Birmingham are cited because of the comparison that can be drawn between two plants having the same type of equipment and supervision—a small plant treating a relatively weak sewage and a 12-mgd plant receiving a relatively strong sewage from the same municipality.

Until recently, evaluation of costs at the full-scale Dearborn plant has been impossible because of complicated operating methods involving a combination of sludge and sewage treated as a mixture. In the near future published operating costs translated in terms of sewage treatment, as distinct from sludge handling, are expected. Improved flocculators, better and simplified chemical control, alterations in the clarifier, have been productive of increased efficiencies, reduced operating costs, and a higher degree of purification.

FUTURE OUTLOOK FOR CHEMICAL TREATMENT OF SEWAGE

Considered as an intermediate process, effective in varying degrees according to varying conditions and adapted to intermittent or continuous application, chemical treatment demands due consideration. The increasingly difficult problem of trade-waste disposal, and the effects of such wastes on more favored biological processes, would indicate an expanding demand for chemical treatment of both municipal and industrial sewages. These may be treated in whole or in part, and the chemical process may be the only one used or it may be employed to prepare difficult sewages for further treatment biologically. In either case its application may become seasonal only.

There is definite indication that a combination of sedimentation and chemical precipitation will be productive of the greatest improvement in average stream conditions for the smallest investment in plant structures and appurtenances, and the lowest fixed charges and operating costs. In some cases, biological treatment will be required either alone or to supplement chemical treatment.

In the hands of plant operators, chemical treatment should become a valued "shock absorber" to reduce the loadings on biological plants during peak hours on certain days in the week or weeks in the year. To relieve odors and prevent the attack of sewer gas on masonry, the addition of iron salts to sewers above the point of odor nuisance or structure damage has much to commend it, as evidenced by results already attained.

Combination plants, including chemical precipitation and the old, reliable, and rugged trickling filter, should be considered for small and medium-sized installations. In such cases the filter loading will be limited possibly only by the amount of liquid it can pass without "drowning." This is because the organic content, especially the slime-producing part, which most seriously loads trickling filters and necessitates coarse media with large voids, will have been almost completely removed as will also the odor-producing compounds and fly-breeding substances that accumulate on the upper stones. At points where there is a marked seasonal variation in population, chemical precipitation prior to filtration can be suspended during seasons of low load. Thus, for resorts this combination is most promising, practical, and economical. Its advantages cannot be overlooked by the sewage economist, and deserve the careful consideration of engineers.

THE PATENT SITUATION

In general, patents covering processes of sewage treatment have served to stultify the growth of such processes in the municipal field. However, patents covering equipment have a different, a more supportable, and a more secure position in this field. Most process patents must be tested in court before the engineer, unfamiliar with patent law, can ascertain their validity and differentiate the worthless claims from the legitimate and basic ones which have scientific value.

Any form of litigation or threatened litigation will work hardships on all interests in chemical treatment and turn back prospective and progressive developments. The patentees on chemical precipitation processes have done much to stimulate the growing interest in a valuable method; full credit for this is due them. But only the future can decide what success they will have with procedures designed to promote their processes, especially considering the ease with which such patents can be circumvented in a field as old as chemical precipitation and as variously patented as it was in the last century. There can be no such thing as a basic patent covering chemical precipitation, and therefore infringement on combinations that go to make up process patents can be circumvented without material difficulty.

Evidence that patents need not block progress in chemical treatment is found in the adaptation and efficacy of the procedure employed in the successful plant at Birmingham, which incorporates a variety of patent-protected equipment but has paid neither license fee nor royalty to anyone. Nor have the Birmingham authorities been advised of infringement. This situation has attracted the attention of the Minneapolis–St. Paul authorities, who have announced that the Twin-Cities plant is to be patterned after the one at Birmingham and is to employ basically the process there used.

On the other hand, for self-protection, process patents may be justifiably taken out by individuals or corporations, who may license users at a nominal fee, thus offering protection to the user against infringement claims by others and likewise preventing exploitation.

FURTHER IMPROVEMENTS IN CHEMICAL TREATMENT ANTICIPATED

Modern methods of chemical treatment have not yet emerged from the experimental stage. The value of returned sludge, series operation of clarifiers, sludge thickening, and flocculation equipment have been proved only within the year. It is reasonable to assume that other improvements, involving simplification of process and control, with concurrent reduction in chemical consumption and operating costs, are certain to ensue. Improved applications of the process and better evaluation of its effectiveness will grow out of a broader experience and the extensive experimentation and research now under way, or to be undertaken. Committees are being established in technical societies to study and evaluate chemical treatment processes, and much of universal benefit may be expected to result, as was the case in the similar study of sewage chlorination.

The methods pursued by promoters of chemical processes in the past have been too frequently such as to create doubt regarding their efficiency in the minds of experienced sanitary engineers and chemists or to arouse the antagonism of this group. The result has been a conservative or reactionary resistance, and unfortunately a temporary setback for chemical treatment in general. The successful operation of a few more plants like that at Birmingham, however, will soon overcome such prejudices. The period of "watchful waiting," on the part of interested authorities, will then have come to its end, and chemical treatment will occupy the position it rightly deserves.

Some Experiences at Birmingham, Alabama

By H. H. HENDON

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THE Shades Valley Plant at Birmingham, Ala., is designed to meet the varying seasonal needs for sewage treatment. It was at the suggestion of L. H. Enslow, Assoc. M. Am. Soc. C.E., that precipitation was investigated and afterwards selected as the method of treatment for this plant. A multiple-valve arrangement in a control chamber permits a quick change in operation from complete chemical treatment with a maximum capacity of 2 mgd to primary treatment by parallel sedimentation with a capacity of 4 mgd. In general, complete chemical treatment is used throughout the summer and primary treatment only in the winter. Since the two clarifiers are at the same elevation, to obtain parallel sedimentation, a turbo-mixer is provided at the entrance of the flocculator to serve both as a low-lift pump for whatever small loss in head results when operating in series, and as a flash mixer for the chemicals and sewage. As an aid to primary sedimentation, chemical sludge is returned continuously from the secondary clarifier to the raw sewage. This

mixture can then flow through half of the flocculator and thence to the primary clarifier, or directly to the primary clarifier.

The raw sewage has an average bio-chemical oxygen demand of 80 ppm and a maximum of 200 ppm; an average suspended solids content of 100 ppm and a maximum of 300 ppm. The oxygen demand of the effluent is 10 ppm or less, and the suspended solids content is 9 ppm. The iron content of the raw sewage is 2 ppm. and that of the effluent, 1.5 ppm. The pH value of the raw sewage is 7.1 and that of the effluent, 6.8. A striking proof of the clearness of the effluent is the fact that the cleaning mechanism on the bottom of the final settling tank can be plainly seen. These results were accomplished by the addition of an average of 70 lb of chlorine and 440 lb of ferrous sulfate per million gallons of sewage treated, which is equivalent to 290 lb of ferric chloride, on the basis of iron content.

SHADES VALLEY CHEMICAL SEWAGE TREATMENT PLANT, BIRMINGHAM, ALA.

View from Main Building, Showing in the Foreground the Flash Mixer, Control Valve Chamber, and Flocculator; Beyond, the Pre-Settling and Precipitation Clarifiers Operating in Series; and in the Background, the Sludge Beds

COSTS OF CONSTRUCTION AND OPERATION OF PLANT TREATMENT

The construction cost of the plant was $108,000. The operating force consists of a young graduate sanitary engineer, who is in charge of the plant and does the necessary laboratory work. Two men are employed as operators in the daytime and one at night. During the spring and summer there is a negro janitor, whose only duty is the maintenance of the grounds. Operating costs, including fixed charges at 7½ per cent, are $23.65 per million gallons of sewage treated. The cost of chemicals will average about $5.50 per million gallons, based on a price for ferrous sulfate ($FeSO_4 7H_2O$) of $17.50 per ton and for chlorine of 3 cents per lb. These prices will appear high to managers of larger plants or to those nearer the source of production of chlorine.

In 1932 the 12-mgd Ensley plant was built at an installation cost of $176,000. It is estimated that this modern mechanized plant, providing for separate sludge digestion, can be modified for complete chemical precipitation by the installation of flocculators and equipment for chemical control at an additional installation cost of $36,000. The estimated cost of chemicals at this plant, based on extensive experimental work, would be $6 per million gallons of sewage treated, using the prices of chemicals given previously for the Shades Valley plant. The cost of complete chemical treatment would be $13.84 per million gallons of sewage treated, including fixed charges at 7½ per cent.

PROCEDURE FOR CHEMICAL CONTROL

Control of chemical dosage and frequency of change in the dosage of copperas and chlorine is important. In the raw sewage there are two principal variables, volume and strength. The daytime flow is approximately twice the night flow, and at the same time, even in the daytime, the strength varies within very wide limits. At Shades Valley, this variation is abnormal, since solids accumulate by sedimentation in the large intercepting sewer leading to the plant and then are flushed out by scour. The suspended solids content of the raw sewage has been known to change from 40 ppm to 700 ppm in one hour. Fortunately, the preliminary settling tank serves to average these variables before the chemicals are applied. At the same time, it gives the operator an hour to experiment, if necessary, with the sewage before it reaches the point where the chemicals are applied. Preliminary sedimentation is of as great value, or greater, in this respect, as it is in the actual savings effected by reducing the amount of chemicals required. In general, the chemical dosage is changed seven times daily to effect the greatest practical economy.

Much thought and study have been given to operating results at Birmingham in an effort to determine what causes the varying chemical demand of the three Birmingham sewages. There seems to be no direct relation between the percentage of suspended solids or total solids present and the amount of coagulant required.

SOME DETAILS OF THE SHADES VALLEY PLANT

Left, Main Building; Center, Chemical Control Room; Right, Interior of Laboratory

At the Shades Valley plant, treating a fresh sewage with as little as 20 ppm of suspended solids coming from the preliminary sedimentation tanks at times, about 400 lb of chlorinated ferrous sulfate per million gallons will be required. On the other hand, at the Ensley plant a stale sewage, having 100 ppm of suspended solids in the settled sewage and a bio-chemical oxygen demand several times that of the Shades Valley sewage, requires but 600 lb of chlorinated ferrous sulfate per million gallons. The reason for this small difference, in the face of a large difference in sewage strength, has not been determined. Considerable work has been done in the laboratory in an effort to find some relation between the colloidal solids and the amount of coagulant required.

INTERMEDIATE VERSUS COMPLETE TREATMENT

The return of sludge to the raw sewage, in addition to reducing the chemical cost by increasing the efficiency of the primary clarifier and reducing the cost of odor control, gives a uniform mixed sludge in the primary tank containing 4 per cent of solids or more. The amount of sludge produced by this process is only about 10 per cent more, on the basis of dry weight, than the amount of actual sewage solids removed. This mixed sludge is digested in a two-stage system consisting of a mechanically stirred and heated primary tank and a plain unheated secondary tank. The digested sludge is dried on open beds.

When the Shades Valley Plant was designed, it was thought that any desired intermediate degree of treatment could be obtained by simply adjusting, or changing, the amount of coagulant added. In our experience to date, where filtration of the effluent has not been involved, this has not been true. The sewage requires well-defined minimum amounts of coagulant (chlorinated copperas) before it will "crack." If the iron is then reduced, the effluent looks very much like that from an activated sludge plant when the sludge is bulking. When sufficient iron is added to "crack" the sewage, however, the floc settles very readily and gives a clear effluent without filtration. In the final precipitation or settling tank, the floc is deposited in an almost perfect cone around the center feed of the clarifier while around the edges of the tank the cleaning mechanism on the bottom can be plainly seen. When sufficient iron is added, there is less than 10 ppm of suspended solids and approximately the same oxygen demand in the final effluent.

Even with the extremely strong sewage at the Ensley plant, at which a small-scale experimental plant has been in operation for some time, the oxygen demand of the final effluent is 25 ppm, or less. Although this may be considered far from perfect, it certainly compares favorably with other known processes. We at Birmingham feel justified in speaking of this as complete treatment and not merely as intermediate treatment.

Operation and Improvement of Dearborn Plant

By MARK B. OWEN

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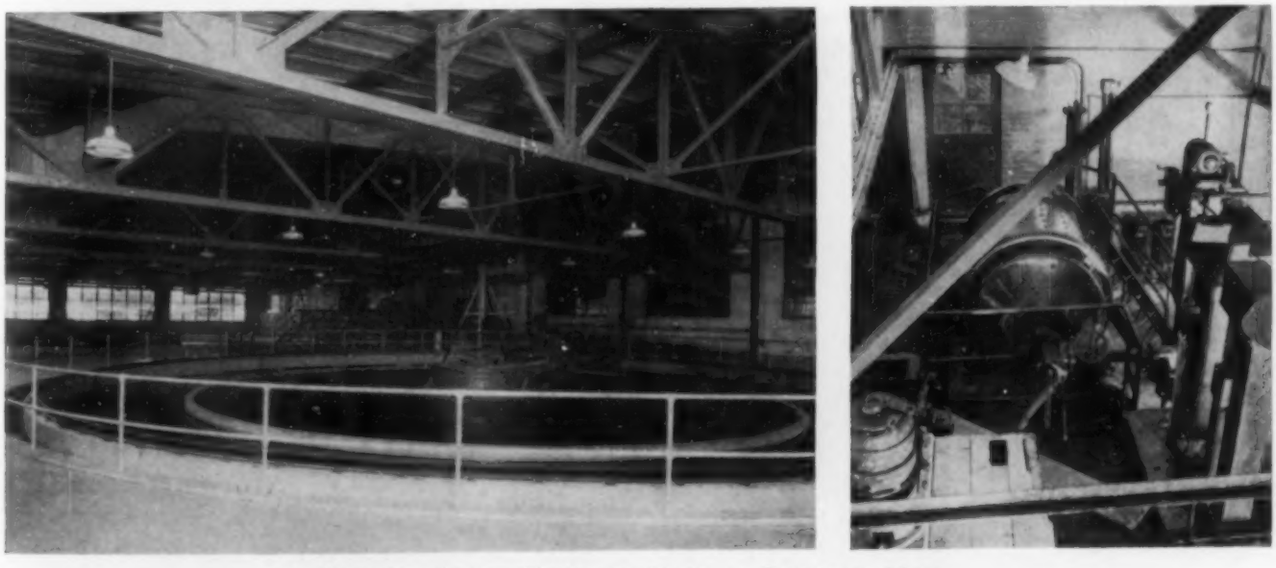
IT is less than four years since the first of the newer chemical sewage treatment plants was built—the West Side Plant at Dearborn, Mich. The revivification and consequent modernization of this type of sewage treatment may be traced to an unusual situation. If Dearborn took the leading part in the rebirth of chemical treatment, it was because of the insistence of Henry Ford that the plant should be located in a park or underground. The customary plant, requiring many acres of land and large open sludge beds, was definitely forbidden. Since the only available sites were owned by Mr. Ford, his insistence eventually resulted in the construction of a chemical–mechanical plant.

The West Side chemical treatment plant is designed



CHEMICAL SEWAGE TREATMENT PLANT AT DEARBORN, MICH.

Left, One of the 60-Ft Clarifiers, with Central Feed from Flocculators, Which Are Not Shown. Within the Clarifier a Peripheral Upflow Filter with Magnetic Filtering Medium Is Suspended. Right, One of the Two Sludge Mixers with the Automatic Chemical Feeder Observable on the Right

to treat 8 mgd. At present about 3 mgd are being treated in addition to the sludge from the older East Side Plant, treating approximately 17 mgd. The chemical plant therefore is a solids handling plant; that is, it

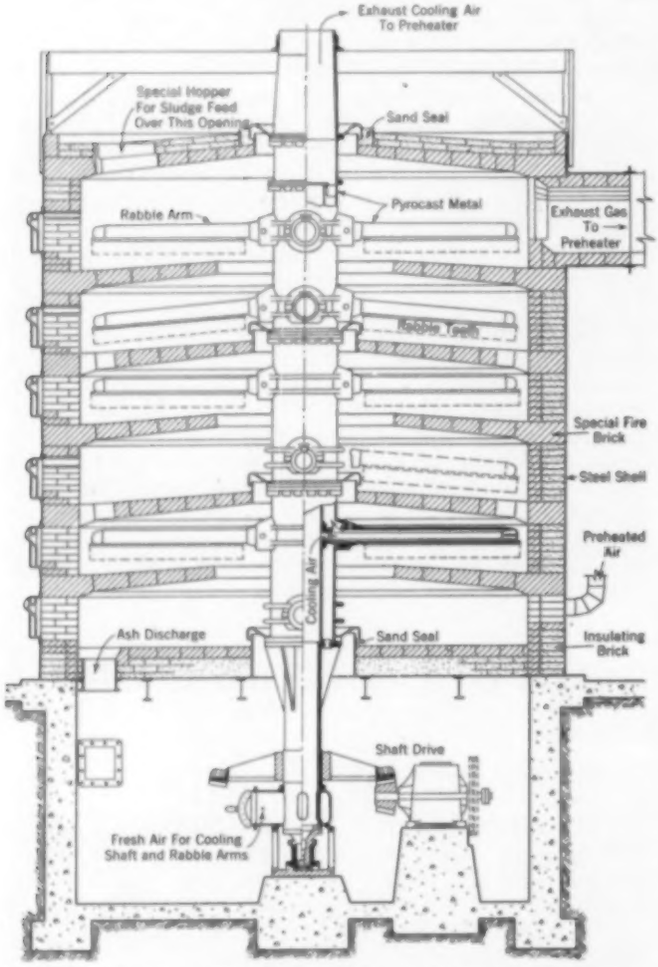


FIG. 1. SECTION THROUGH NICHOLS–HERRESHOFF SLUDGE INCINERATOR INSTALLED AT WEST SIDE PLANT, DEARBORN, MICH.

finally disposes of the solids from a population of about 200,000 people plus only 3 mgd of untreated sewage.

TABLE 1. RELATION BETWEEN STRENGTH OF SEWAGE AND CHEMICAL DOSAGE

Lb per Million Gal		Suspended Solids		B.O.D.		pH	
CaO	FeCl₃	Influent	Effluent	Influent	Effluent	Influent	Effluent
296	376	213	15	128	23	7.5	7.9
218	338	398	6	262	22	7.5	7.8
154	271	68	10	44	16	7.3	7.6
150	232	131	18	81	19	7.4	7.8
216	433	174	8	102	30	8.1	7.9
210	310	831	34	380	36	7.5	7.9
307	314	484	11	190	13	7.5	7.8
132	364	1,298	14	265	13	7.7	7.6
180	439	1,050	17	440	27	7.4	7.8
185	350	93	5	60	10	7.5	7.6
222	480	662	14	265	21	7.3	7.7
234	465	297	17	135	22	7.6	7.6
118	216	43	14	44	11	7.4	7.7
122	226	1,970	10	290	11	7.4	7.5
63	149	124	23	16	13	7.6	7.9
48	98	39	34	23	12	7.6	7.9
170	305	38	20	21	10	7.7	7.9
213	205	1,461	20	295	19	8.2	7.9
187	239	1,360	16	235	13	8.8	8.6
170	268	1,890	16	370	17	7.5	7.7
98	275	802	24	290	21	7.5	7.7
Maximums:							
307	480	1,970	34	440	36	...	...
Minimums:							
48	98	38	6	16	10	...	...

For three years we have tried without success to establish a relationship between the strength of the sewage and the required chemical dose. For example, Table I lists actual operating conditions and results from the Dearborn plant. On certain days a composite mixture of sludge and sewage was treated as a strong sewage. On other days the sewage was highly diluted by storm water. The wide range of conditions has been encountered in regular operation many times in the past three years. The table therefore illustrates effectively the lack of relationship between these two factors.

Sewages having a high content of suspended solids or a high oxygen demand do not necessarily require large chemical doses. It is generally much easier to produce a good effluent from the strong sewage than from the weak. Some method of quickly determining the proper chemical dose is greatly needed. Whatever is developed should be so simple that the average sewage plant operator can use it. A good operator eventually acquires the uncanny ability, or sixth sense, of telling without laboratory apparatus when a sewage is improperly dosed and whether it has too much or too little lime or iron. At Dearborn, the operators make many determinations of the pH value of the sewage during their tours of duty and these may or may not result in changing the chemical feed. Such a change is discretionary with the senior operator of each shift and may be made hourly if conditions indicate the necessity for it. The importance of constant control cannot be overlooked.

ALTERATIONS AND ADDITIONS TO THE PLANT

In July 1934, the last published reports on the Dearborn plant appeared. The following month contracts were awarded to alter some of the equipment and add new equipment for more economical operation. These changes are just being completed and have not been in operation long enough to discuss the results. They include new lime mixers, new chemical feed machines, air mixers for chemicals and sewage, mechanical flocculators, central siphon feed to clarifiers in place of overhead feed, bucket-elevator sludge feeders in place of centrifugal pumps, sludge mixers and conditioners, rubber-lined steel tanks of tank-car capacity for storage of ferric chloride, and last, the installation of the world's first full-sized sludge incinerator.

Before the West Side Plant was built, a laboratory mixer was devised for mixing chemicals with sewage and for floc formation. The results indicated that a plant-sized installation would result in chemical savings up to 30 per cent. However, flocculators as they are now known, were not on the market at that time. A baffled mixing channel has been used for chemical mixing and flocculation with indifferent results until recently, when the flocculation equipment was installed. The results so far noted bear out the findings of five years ago, and a reduction in consumption of chemicals has already been made equaling 30 per cent.

SLUDGE DISPOSAL BY INCINERATION TO BE INITIATED

As has been mentioned, the West Side Plant is really a solids handling plant. For the 12 months ending April 1934 it turned out 21,645,000 lb of sludge cake from Oliver filters, averaging 64.4 per cent of moisture. The filter production for this period averaged 9.0 lb of dry solids (lime excluded) per sq ft of filter per hr.

Since the plant is about 17 miles from the nearest agricultural area, the problem of sludge disposal is acute, and disposal is costly. Four years ago when the plant was built the estimate included funds for a sludge incinerator. Although a multiple-hearth type of furnace

was contemplated at that time, it was deemed advisable to postpone the purchase until more data were available on volumes of sludge to be handled and until tests on sludge burning were completed.

Now a sludge incinerator has been installed (Fig. 1) and is ready for operation. The type of furnace acquired permitted installation inside the filter room of the existing building without any structural alterations. The sludge conveyor belt had to be changed only slightly to discharge the sludge cake directly into the furnace.

This incinerator is of the Nichols-Herreshof type, similar to those long used in the fields of metallurgy, chemicals, and petroleum. It is 18 ft 6 in. in diameter, contains six hearths, one above the other, and is guaranteed to incinerate to a clean ash 50 tons of sludge containing 65 per cent of moisture and 35 per cent of volatile solids, or the equivalent, per day. Also, the burning must be done without odor and smoke. The hearths are constructed of special high-grade fire brick and are designated as "in-feed" or "out-feed" depending on whether the sludge cake outlet from the hearth is at the center or at the outside.

Horizontal arms attached to a central vertical shaft, which revolves, carry rabble teeth which by their pitch move the burning sludge across the hearth to the outlet at the center, or periphery, of alternating hearths. During its travel the sludge is constantly turned to expose new surfaces to the heat. Oil burners are provided on the top, second, and fourth hearth. Sludge is fed in on the top hearth and is slowly rabbled through and across each succeeding lower hearth to the ash chute for final disposal.

Cooling of the central shaft and rabble arms is effected by air from a blower. The air passes inside the walls of the arms and shaft to a duct leading to a preheater. Exhaust gases from the furnace are passed around carborundum tubes in the preheater and then through the heating boilers of the sewage plant before discharge to the atmosphere. The cooling air from the rabble arms passes through the carborundum tubes to be heated to a higher temperature before returning to the furnace to support combustion. Experiments and tests already completed indicate that the volume of the ash will be from 15 to 20 per cent of the wet sludge cake entering the furnace.

Under the guarantee, consumption of fuel oil is not to exceed 12 gal per ton of wet feed. Tests have indicated so far that with the sludge cake now produced, consumption will not exceed 6 gal per ton of wet feed.

Operation of Chemical Treatment Plants

By ELSON T. KILLAM

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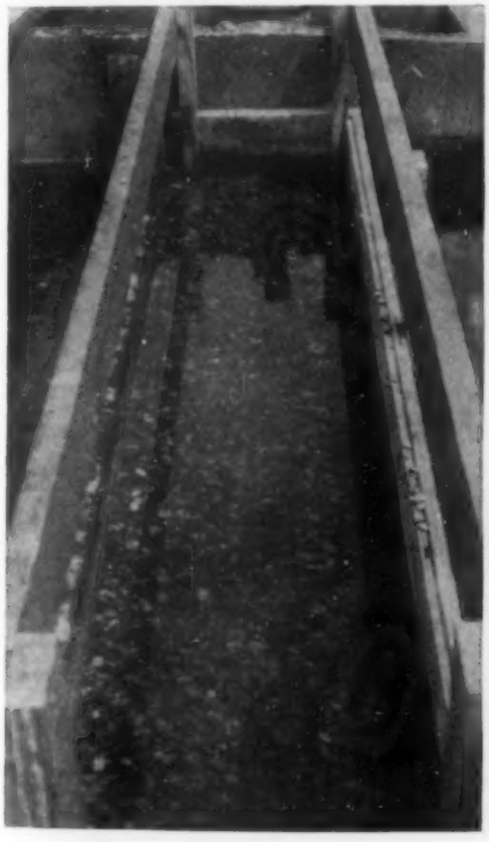
IN the operation of sewage treatment plants of the chemical type, equipped with modern facilities, a number of questions arise that have not arisen in the operation of other types of treatment plants. In nearly every case these questions are related to the basic problem of flexibility in operation. While the feasibility of variable operation has been debated, and while such variation involves special problems, on the whole flexibility is a most valuable asset. The economic necessity for such operation and the ability to obtain it are often the controlling factors in determining whether or not chemical treatment shall be chosen for a specific location.

Flexibility of operation may be conveniently discussed under the following headings:

1. Its necessity to handle economically and efficiently variations in incoming load.



PEACH TREE DEMONSTRATION PLANT FOR CHEMICAL TREATMENT OF SEWAGE, ATLANTA, GA.

Left, a Natural Floc Precipitated by Simultaneous Arrival of Both Acid and Alkaline Industrial Wastes—an Economy Possible with a Chemical Plant. Right, Effluent Leaving Clarifier After a Detention Period of 1 Hr; Clarity Indicated by Visibility of Submerged Gravel

2. Its necessity to vary the degree of treatment to match variations in the receiving waters, so as to keep them in proper condition.

3. Operating procedure to meet variations both in incoming load and in quality of plant effluent.

HOURLY VARIATIONS IN INCOMING LOAD PRESENT PROBLEMS IN SEWAGE TREATMENT

In water treatment, variations in the incoming load have been recognized and frequently provided for in design. However, such variations are negligible in magnitude as compared to those met with in sewage treatment. In a water plant, the changes occur daily, monthly, or seasonally, instead of hourly, as in the case of a sewage plant. An additional factor of importance in this comparison is that the output of a water plant has a comparatively definite year-round standard of quality, whereas economy and efficiency of operation in a sewage plant may require a degree of treatment varying, from month to month, between rough preliminary treatment and complete secondary treatment.

The comments on operating problems which follow are based primarily on observations made in the operation of a test plant for chemical treatment at Atlanta, Ga., handling an average flow of 0.5 mgd. This plant was operated on a 24-hr schedule during a period extending from March to September 1933. The plant was designed and operated for the specific purpose of obtaining such data. With a staff averaging eight engineers and chemists, exclusive of the men engaged directly in operation, there was opportunity for a rather detailed analysis of operating problems and results.

Variations in incoming load assume major proportions when changes in rate of flow and in concentration of sewage are compounded. Investigation of one small plant serving only 2,200 people, in which the variations in both strength and flow might naturally be expected to be relatively great, revealed that the 2-hr period of maximum load was produced by a suspended solids content of 450 ppm accompanying a rate of flow of 0.26 mgd and resulting in a load of 41 lb of suspended solids per hour. In the 2-hr period of minimum load, from 6:00 to 8:00 a.m. a suspended solids content of only 1 ppm and a coincident flow of only 0.067 mgd was found. This low concentration and low rate of flow produced a load of 0.023 lb per hr instead of 41.0 lb per hr, as in the period of maximum load. Accordingly, comparing the two 2-hr periods, the ratio of maximum to minimum load was 450:1 based on concentration, and 3.88:1 based on flow, resulting in a combined effect, or load factor, of 1,750:1.

EVEN IN LARGE SYSTEMS LOAD IS FOUND TO VARY CONSIDERABLY

In large systems the variations are naturally not as great, although in each of the four systems investigated by hourly analysis, very substantial variations were encountered. In one system jointly operated by 12 municipalities, involving many miles of intercepting sewers, and serving a population of 228,000, the following conditions, believed to be typical of large systems, were found. In the hour of maximum load, the suspended solids content was 302 ppm, accompanying a rate of flow of 19.75 mgd and resulting in a suspended solids load of 2,070 lb per hr. In the hour of minimum load a suspended solids content of 46 ppm, accompanying a rate of flow of 7.28 mgd, resulted in a load of 116 lb per hr.

Accordingly, even in this system, which is subject to many conditions tending to smooth out variations, the ratio of maximum hourly load to minimum hourly load was 6.66:1 based on suspended solids content, and 2.72:1 based on flow, resulting in a combined effect, or load factor, of 18:1. The extent of the variations in this large system may perhaps be more clearly illustrated by the statement that the entire flow of raw sewage had a lower oxygen demand during a 5-hr period in the early morning than would the effluent of an activated sludge

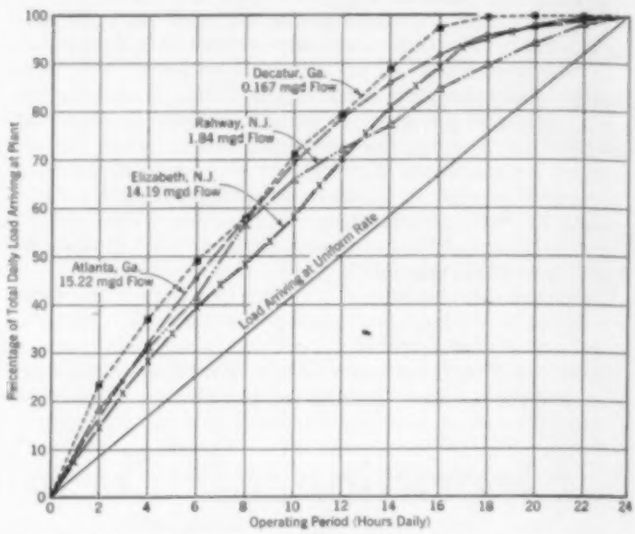


FIG. 1. RATE OF ARRIVAL OF TOTAL DAILY LOAD AT VARIOUS PLANTS

Cumulative Load Curves Based on Both Quantity of Sewage and Amount of Suspended Solids Present

plant operating at 90 per cent efficiency in the same system on the relatively strong sewage and high rate of flow during the 5-hr period when the heavy loads occurred.

CUMULATIVE LOAD CURVES

These load variations and their relation to operating procedure may be conveniently expressed by cumulative load curves, in which the load for the hour of maximum load and that for each successive hour of decreasing load are added, resulting in curves of the form shown in Fig. 2. From the data shown in this diagram, it may be concluded that in each system there is a surprising uniformity in the percentage of the total daily load arriving in any given number of hours, even when the comparison involves systems serving tributary populations varying from 2,200 to 228,000. The average condition for the four systems upon which a comprehensive investigation was conducted was as shown in Table I.

TABLE I. PERCENTAGES OF TOTAL DAILY LOAD ARRIVING DURING VARIOUS PERIODS

LENGTH OF PERIOD OF OPERATION	PERCENTAGE OF TOTAL DAILY LOAD ARRIVING
4 hr.	32%
8 hr.	55%
12 dr.	75%
16 hr.	91%
20 hr.	97%

SIMILAR LOAD VARIATIONS IN B.O.D. AND CHLORINE DEMAND

For three of the four cases illustrated in Fig. 1, similar curves for bio-chemical oxygen demand have been prepared. It is found that for all practical purposes the cumulative load curves based on oxygen demand and

flow are identical with the curves based on suspended solids and flow. It has also been found that variations in turbidity, organic nitrogen, and chlorine demand follow very similar trends. Variations in chlorine demand are of particular economic significance because of the wide use of chlorine in sewage treatment. In the large system previously mentioned, demands varying from 25 to 6 ppm were found. Considering coincident rate of flow, these involved a load ratio of 10:1, indicating the degree of economy possible by a variable and controlled chlorine feed.

With loads varying as widely as has been indicated, the advantage of flexible operation is obvious. The concentration of a substantial part of the total daily load into a relatively short period has an important bearing on operating efficiency and cost. The most significant factors relative to operating procedure resulting from these conditions are two: curtailment of the number of hours during which supplementary treatment or chemical feed is required; and concentration of operation on the heaviest sewage, which can be treated more efficiently by chemicals than can the lighter sewage.

Outlook for Chemical Sewage Treatment

By WELLINGTON DONALDSON

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THAT there is a revival of interest in chemical methods in this country is attested by the recent choice of part-time chemical treatment by large communities like the Twin Cities and New York City—for its Coney Island project. Other interesting new projects employing chemical methods are at Perth Amboy, Birmingham (Tarrant City and Ensley plants), Raleigh, and San Luis Obispo, Calif. At this time there are between 45 and 60 installations in operation, under construction, or planned. Out of the experience being gained in various parts of the country, both experimentally and by plant operation, have come two significant things, increased efficiency of treatment and lowered costs.

Only a few years ago it was assumed that the practical efficiency of chemical precipitation was a removal of 60 to 70 per cent of the biochemical oxygen demand, as contrasted with 35 to 40 per cent removal by plain sedimentation, although excellent clarification was obtainable even with lime alone as a precipitant. The Dearborn plant, with its Laughlin filters, precursor of the modern type of precipitation plant, showed improved efficiency and laid down a pattern for better handling of sludge. According to the tests reported by Buswell in the March 1934 issue of *Water Works and Sewerage*, the plant removed 92 per cent of the suspended solids and 75 per cent of the oxygen demand. The resulting efficiency may conveniently be designated as 92/75. Subsequent improvements in the Dearborn plant, incorporated also in the Perth Amboy installation (now practically completed), are expected to better these results. The Palo Alto experimental plant, with three-stage settling, had an efficiency of 95/95 according to Stevenson, while the simplified two-stage settling gave an efficiency of 83/66. The Guggenheim pilot plant, employing zeolite filters, operated at Chicago, had an efficiency of 97/91. No test results have been published of the modified Guggenheim process without zeolite filters, as planned for the two plants at Raleigh. Hendon in his paper delivered before the New York State Sewage Works Association, published in *Water Works and Sewerage* for March 1935, reported an average efficiency of 91/88 for the Shades Valley plant at Birmingham, without filters. Tests of an experimental plant on a stronger sewage at the Ensley works indicated even higher efficiencies.

Although caution should be exercised when comparing test results of the new chemical processes with the routine operating results of older processes, the indication is plain that chemical methods, if intelligently used, are capable of providing a higher degree of treatment than has generally been attributed to them. No doubt the greatest utility of chemical methods will be for intermediate treatment or for part-time operation to take care of summer conditions or low stream flow. However, chemical methods as they are now known are not necessarily bound by such limitations as to duration or extent of application. In fact, they are likely to compete strongly with the best biological methods on the bases of cost, efficiency, flexibility of operation, and nuisance control.

POSSIBLE WEAKNESS OF TREATMENT BY MEANS OF CHEMICALS

The greatest weakness of chemical treatment is that its efficiency depends on an uninterrupted application of chemicals in proper doses to suit the sewage demands. The temptation for municipalities to prune the budget for operating supplies is very strong. This human trait has an important bearing on chemical treatment today as it did in 1891 in England, as evidenced by the following statement made in Wardle's *Sewage Treatment and Disposal* (London, 1893):

> There is one practical difficulty which we must frankly admit the process [Spence's alumino-ferric] will not overcome. It will not produce any effect whatever upon the sewage in those cases where a mistaken economy leads sewage committees to save the rates by keeping the precipitating material locked up in their stores whenever they think their effluents are not under observation.

Aside from the possibility of allowing chemical stocks to run low, there is also the practical consideration of making adjustments of the chemical dose to suit variable demands of sewage flow and sewage quality. There is room here for the development of dependable automatic devices to meet constantly changing sewage conditions in order to eliminate the necessity for too close attendance.

The future stability of the chemical market as it may affect chemical treatment of sewage is not in doubt. Already there is competition in a variety of precipitating chemicals suitable for the purpose. As tonnage demands develop new outlets for waste iron products, future price trends should be downward rather than upward. The experience with chlorine would seem a probable parallel.

Rôle of the Sanitary Engineer in Industry

A Large Industrial Corporation Benefits from Continuous Employment of a Sanitary Expert

By A. Clinton Decker

Member American Society of Civil Engineers
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THERE would seem to be no question that the employment of a sanitary engineer by a large industrial corporation is justified on broad social grounds. How it can also be of direct economic value is here shown by Mr. Decker, in an article originally presented by him as an address before the Sanitary Engineering Division on January 17, 1935, at the Society's Annual Meeting in New York. He expresses the hope that this record of his twenty years of experience will have a twofold value—first, to sanitary engineers in calling their attention to a potential field of great professional usefulness, and second, to executives of large industrial organizations in demonstrating to them the considerable economic value of trained engineering advice.

MORE than twenty years are covered by the experiences here recounted. In this period ideas of sanitation and public health have undergone many important and significant changes. The organization with which I am connected, the Tennessee Coal, Iron, and Railroad Company, is a subsidiary of the United States Steel Corporation, and is engaged in the mining of iron ore and coal, the quarrying of limestone and dolomite, the production of iron and steel, and the manufacture of a wide variety of finished steel products. For the housing of its employees it maintains several villages in which it furnishes services normally supplied in incorporated communities by the local government and by utility companies. The services in which the sanitary engineer is particularly interested are water supply, sewerage, and garbage and refuse disposal.

WATER SUPPLIES FROM MANY SOURCES CONTROLLED

When I first became connected with this company, employees living on its property were using a total of more than 350 individual sources of domestic water, including wells, springs, and cisterns. Also there were general water supplies pumped from surface and underground sources and delivered untreated through pipe lines, as well as two provided with filtration plants for villages that had been recently developed. Sanitation was of a very primitive kind, mostly provided by outdoor privies of the so-called dry or surface type. At the iron and steel plants, water from the municipal supply was in use for all drinking and domestic purposes, and some progress in sanitation had been made by providing small septic tanks for the disposal of sanitary sewage from the works and office toilets. Small and inadequately designed bath houses had been installed at most of the mines and manufacturing plants, but these were far from adequate to meet modern requirements as to health and sanitation.

The first work of improving health conditions that came within the province of the sanitary engineer was in connection with water supply. An important adjunct to this, and a matter of importance from the viewpoint of sanitation and esthetics, was the improvement of conditions relating to privies. In attacking the problem of water supply, sampling and bacteriological and sanitary chemical analyses of all sources of water were undertaken. When supplies were found to be polluted and it was impracticable properly to protect their sources, the sources were closed in the most effective manner possible. When a source could be protected from surface pollution, this was done in one of the many ways possible, depending on type of supply. Abandonment of any individual source was found to be very difficult because of the opposition of users. We were frequently told in all seriousness, and sometimes with a considerable show of feeling, that the present family and two generations preceding had used a source, and that there had never been a case of typhoid fever in the family. Bacteriological analyses were made regularly at intervals of not more than six months for all individual sources of water, such as wells and springs, and the general supplies were analyzed weekly.

As more and more individual sources were eliminated, the general sources were extended, and filtration or chlorination, or both, were used to ensure satisfactory quality for domestic purposes. Soon towns of 2,000 population exhibited considerable concern if there were even one or two cases of typhoid, when formerly they had considered it a remarkably good year if there were not more than 50 or 60 cases each summer and fall.

Another factor entering into this remarkable reduction in the typhoid case rate was improved sanitation. In almost all the villages it was impracticable to install a sanitary sewerage system because of topography and the probable life of the settlement. Therefore the outdoor type of privy was maintained, but buildings of good construction were erected, and the so-called can or pail system was instituted. The receptacle was placed in a fly-tight box with a self-closing lid, and adequate screening and ventilation were provided.

A flap door at the back of the building made possible the removal of the cans, which were placed on an especially constructed wagon driven through the alleys and delivered at a central point where their contents were emptied and they were thoroughly washed. The disposal

Typical Sewage Disposal Plant Built by the Company
Dumping Station, Septic Tank, Siphon Chamber, Trickling Filter

of the contents again presented a problem for the sanitary engineer. In some few cases, where cinders and coal-mine refuse dumps were available, large pits were excavated in this porous material. In most cases, however, it was necessary to design some type of sewage-treatment plant, a problem which called into play the ingenuity of the sanitary engineer. Since this waste obviously contained a high percentage of solids, in order to utilize the principle of septic action and digestion of sludge, it was necessary to convert it into a material resembling the contents of an ordinary sanitary sewer. This was done by allowing water to flow continuously into the sewage at the time the cans were emptied, the amount added being equal to 15 or 20 gal per capita per day. Buildings into which the wagon containing the cans could be driven were constructed and provided with the necessary washing facilities. Septic tanks, trickling filters, and sludge beds were built for the treatment of the sewage. Some of these plants have now been in use for 20 years, while others are only 8 years old. In the period between the construction of the first and the last plant, many improvements in design were made as a result of the experience gained in former plants. The plants have all given satisfactory service, and complaints from owners of property below the points at which the effluent is discharged have been negligible.

In 1917 it was decided to construct a shipbuilding plant for the Chickasaw Shipbuilding Company, a subsidiary of the Tennessee Coal, Iron, and Railroad Company, and also to establish a village for employees. Speed was an essential feature because the War made necessary the provision of ships in the shortest possible time. Problems of domestic water supply and sewerage were handled by the company's regularly employed sanitary engineer, whose knowledge of its policies and thorough familiarity with its properties made possible the rapid design and completion of the water supply and sewerage systems, with their necessary treatment plants. It also meant that this work was coordinated with other work of the company more easily than would have been possible if engineers had been called in from outside.

VALUE OF ATTENDANCE AT TECHNICAL CONFERENCES

It has been the policy of my employing company to permit me to attend the conferences of technical and professional societies. Many examples of direct benefits secured from the contacts made, papers presented, and discussions held, might be cited. One instance is of particular interest. At the meeting of the American Public Health Association in Fort Worth, Tex., in the fall of 1930, new minimum requirements for drinking fountain bubblers were adopted. These requirements, the result of many years of study and investigation, were radically different in some respects from the bubblers which were then considered standard.

A short time after this meeting, but before the publication of the new standards, the company was in the market for a large number of electrically operated water coolers with bubblers. My specifications for these coolers included the newly adopted requirements of the American Public Health Association, but all the quotations submitted were for bubblers that did not meet these requirements. In the course of the considerable correspondence which followed, covering a period of about four months, the manufacturers claimed that no bubblers meeting these specifications were made, and I insisted that no others would be accepted. The manufacturers finally agreed to conform to the specifications. If the earlier proposals had been accepted, the company would have had on its hands nearly $7,000 worth of equipment which would have been out of date by the time the installation was completed. Furthermore, the employees would have been subjected to the danger of disease transmitted through the use of the equipment.

Bathing and locker-room facilities for employees at mines and manufacturing plants are essential to the best interests of both employee and employer. Frequently, however, the facilities furnished are very poorly designed and absolutely inadequate. Here again the sanitary engineer can play an important part by being responsible for the type of design and the number of units furnished in bath houses. These factors of course will vary, depending on the type of work in which employees are engaged, and for that reason the number and arrangement of showers and hand-washing facilities may differ materially in different departments or divisions of the same works.

TYPICAL SHOWERS AND SINKS IN WORKS BATH HOUSE

In the matter of toilet facilities, there has been a material advance during the past twenty years. As a result, improvements in design and arrangement of facilities, provision of proper light and heat, and sanitary and general health conditions in connection with these units have been materially improved. Incidentally, the loss due to absence of employees from their places in the plant for protracted periods has been very considerably reduced.

Since several villages have always been maintained by the company—at the present time there are 13, ranging in size from 75 to 3,500 people—it has always performed the services of garbage and refuse collection and disposal. In order to eliminate dumps, which are unsightly and unsanitary at best, incinerators were designed for use in all but the smaller communities. These were designed to burn the garbage, trash, and small animals collected in the plants and villages without auxiliary fuel. In some instances even mules and cows have been burned in them.

ENGINEER AIDS IN DRAWING UP WATER WORKS LEASE

When in 1927 the Alabama Water Service Company secured a franchise for furnishing water to the City of Prichard, Ala., and adjacent unincorporated territory in Mobile County, it expressed an interest in the possibility of leasing the water works property which had been developed for the plant and village of the Chickasaw Shipbuilding Company, a large part of which had been abandoned. The details of this lease involved questions of fire protection and domestic service within that part of the Chickasaw village which was still maintained by the company. Also the question of the construction of a

filtration plant on these properties was an important factor in the preparation of a lease that would adequately protect the interests of the Chickasaw Company and at the same time be reasonable and fair to the water company. Again the experience of the sanitary engineer was utilized, with the result that a lease was prepared which has been thoroughly satisfactory to both parties over a period of years.

When it was definitely decided to construct a water works for filtration and color removal, preliminary investigations to determine the type of plant and method of operation were made by the sanitary engineer of the company in cooperation with the sanitary engineer of the State Health Department. It happened that in this work the use of chlorinated copperas was demonstrated to be far more economical and efficient than treatment with other chemicals. In view of the fact that sugar iron sulfate (copperas) is produced and sold by the Tennessee Coal, Iron, and Railroad Company, the experimental and supervisory work done by its sanitary engineer was beneficial both in that it safeguarded the company's interests in the design and construction of the filtration plants and also in that it demonstrated the efficacy of iron sulfate as a coagulant, especially for water difficult to treat by other commonly used chemicals.

TYPICAL LOCKER ROOM IN WORKS BATH HOUSE

Hanging Lockers Controlled by Chains and Individual Locks; Type of Heat and Ventilation Control Also Shown

COOPERATION WITH LOCAL GOVERNMENTAL UNITS

The sanitary engineer of the Tennessee Company had always worked in close cooperation with the Sanitary Engineering Department of Jefferson County and with the Engineering Department of the City of Birmingham. When it was decided to undertake a comprehensive program of sewage treatment in Jefferson County, which is a sanitary district supported by a tax of 0.3 mill per $100 of valuation, the sanitary engineer of the company was called upon to cooperate in the studies made by the county. He devoted a considerable amount of his time to working with its sanitary engineer, in such ways as the latter desired.

When the City Commission of Birmingham appointed an Engineering Commission to investigate and report on a proposed industrial water supply, the sanitary engineer of the company was requested to serve as one of its three members, and with the permission of the management he has so served for a period of more than two years. The application later made to the Public Works Administration for a loan and grant for the required construction was vigorously pushed by the Engineering Commission.

The development of new uses for steel has been a field of major importance to the steel industry. When active campaigns were initiated by several state health departments in the South for the construction of pit-type privies, it occurred to the sanitary engineer that here might be another use for steel. As a result, he studied the problem from the standpoint of health. With his knowledge of the merits of the material produced by his employing company, an all-steel building was developed for use with this type of sanitation. Because of features of economy and sanitation, this building opened possibilities for the sale of a considerable quantity of steel, the amount used in one unit being approximately 1/4 ton.

ACCURATE RECORDS SAVE TIME AND MONEY

Although there is a certain amount of work of a routine nature which is constantly required of a sanitary engineer, there is a large amount that is intermittent in the field of design and construction of sanitary engineering works. Therefore certain periods were available for systematizing the plans and records of earlier installations. It had been observed that the records of water lines and sanitary sewers in the plants and villages of the company were very obscure, inaccurate, and in some cases entirely lacking. Many times long lines were constructed to reach certain locations, when if accurate records had been available only a tap with a short service line or a relatively short main extension would have been needed. Also, in the matter of fire protection, the adequacy of the water supply for the various fire hydrants could not be determined except by actual test, and then inadequacy might mean any one of several things, the determination of which would involve the expenditure of considerable time and money.

It appeared that an adequate system of records for all works and villages would be of considerable value in making extensions to the existing sanitary system, in providing service from it, and in rearranging and strengthening particular lines or groups of lines that might be involved in a given study. To this end a series of record maps were prepared, on scales from 20 ft to the inch to 50 ft to the inch, depending upon the degree of congestion in the area involved. These records show the location and type of every water line, both domestic and industrial, including taps, fittings, fire hydrants, valves, storage tanks, and pumping and purification plants. They also show every sanitary sewer with its manholes, wyes, and other appurtenances, and all sewage treatment plants and garbage and refuse incinerators.

Photostatic reductions of these maps were made, and a loose-leaf binder containing the sheets pertaining to each individual works or group of plants was furnished to the superintendent and the chief engineer of each such division and also to such other officials as might have need of the information. In addition to the advantages of this type of record already mentioned, I might add that when the studies for the leasing of the Chickasaw Water Works were being made, these detailed and accurate data were of considerable help both to the lessor and the lessee in arriving at values for the facilities available.

This brief review of experience covering over twenty years demonstrates the fact that there is a distinct field for the sanitary engineer in industrial undertakings. The routine of actual sanitary engineering duties, with the maintenance work necessary to keep equipment in the state of high efficiency which sanitary standards demand, calls for skill and experience. In addition there is the effort towards improvement, involving problems of design and construction that are both stimulating and instructive. The special training of the sanitary engineer is essential in many of the activities of large industrial organizations, and if applied will result in benefit to all concerned.

State Surveying and Mapping Bureaus

A Proposed System for Collecting Information and Making It Available

By John S. Dodds

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IN this abstract of his paper presented before the Surveying and Mapping Division on January 16, 1935, during the Annual Meeting of the Society, Professor Dodds proposes the formation of a central agency in each state for collecting and assembling all surveying and mapping data for the area. This agency would collect and file information from both public and private sources and make it available to all engineers, surveyors, and map users. The idea will find general favor with engineers, trained as they are to abhor waste, duplication of effort, and unnecessary expense. To make the plan effective, however, the many surveys and maps available, such as those for highways, railroads, land lines, and construction projects, must be referred to a uniform system of geographic coordinates and elevation datum—an extensive and painstaking task in itself.

A SURVEYING and mapping service generally has a certain salvage value. Contrasting it with other professional services, one can easily understand how this more or less permanent value arises. If one consults a doctor or lawyer, the product is frequently a service for the moment—advice to relieve a present difficulty. However, if the map or boundary solution provided by the surveyor is made available to others, it will make a similar call upon the surveyor needless, although the condition that made necessary consultation with the physician or attorney may arise at any time and require his professional services again and again.

Of course the earth's surface is not a static thing, so that maps require revision to keep them up to date. Not only is man changing the face of Nature by his construction and cultivation activities, but Nature is changing her own face by erosion, silting, glacial and seismographic disturbances, as well as by the destructive agents, fire, wind, and wave. Even so, much information once placed on a map is of value in connection with many projects, if it is readily available at the time needed.

No machinery exists, however, to ensure full use of maps and surveys once they have been completed by the engineer or surveyor. To remedy this situation, it is proposed that a central agency or bureau be established in each state, where one may file or find all possible information of this type, so that the salvage value of surveys and maps will not be lost.

A brief survey of the various state agencies which now serve in some measure as depositories for mapping and surveying information discloses the following:

1. State Highway Commission, Department, or Bureau
2. State Engineer's Office
3. State Surveyor General
4. State Geological Department
5. Department of Water Resources
6. State Planning Board
7. Department or Bureau of Mines and Minerals
8. Department of Land Records
9. State Board of Engineers
10. State Mapping Authority
11. Department of Conservation
12. State Department of Forestry
13. State Weather Service
14. State Health Department
15. State Library
16. State Soils Survey
17. State Drainage Commission
18. State Park Board
19. State Railroad Commission
20. State Utilities Commission
21. State Power Commission

Incomplete as this list is, it indicates the practical impossibility at the present time of going to a central agency and making sure that one has all the information prepared by others regarding any given area. Of the 45 states that have been studied, not one has such an agency.

THE FLORIDA MAPPING AUTHORITY

In Florida a voluntary organization, the Florida Mapping Authority, has been set up with the following characteristics, as quoted from its charter:

1. The purpose of the Florida Mapping Authority is to promote the early completion and publication of an adequate standard topographic map of the entire state of Florida and the securing of all basic data necessary to that end.

2. The Florida Mapping Authority is a voluntary organization in every sense; its members are in no way obligated to any financial expenditures or to any policies or actions not expressly stated herein. Any member may withdraw at any time upon notification of all other members.

3. The members of the Florida Mapping Authority agree to notify the secretary of any contemplated surveys and of their actions and policies in all matters affecting the topographic mapping of the state of Florida, and to file copies of all maps which they have or may make with the Library of the University of Florida.

4. The members of the Florida Mapping Authority agree to have their representatives meet at least once a year or as often as may be necessary to discuss, exchange ideas, and lay plans for the topographic mapping of the state.

5. The members agree to engage in only those mapping functions which are absolutely necessary to the fulfillment of their legal functions and to endeavor at all times to avoid duplication of mapping work which is being done by another state or a Federal agency.

6. The members agree to use their influence at all times to encourage the Federal Government and its several agencies to do as much work as possible in the State of Florida which will lead to the early completion and publication of a standard topographic map of the state.

The membership of the Florida Mapping Authority, although not limited to state agencies, is representative of the wide variety of interest involved in this type of work in one state. It includes the following: the Florida Forest Service; the State Department of Agriculture; the U. S. Engineer Office; the Trustees of the Internal Improvement Fund; the Geological Division of the Conservation Department; the Mosquito and Malaria Control Bureau of the State Health Department; the Engineering Department of the Florida Public Health Service; the Bureau of Public Roads of the U. S. Department of Agriculture; the State Planning Board; the Soil Survey; the State Road Department; the U. S. Geological Survey; and the University of Florida.

Iowa is another example of a state in which an effort has been made to assemble as complete a set of maps as possible to be used in connection with land planning. Since the U. S. Geological Survey has completed its sketch maps, with a contour interval of 20 ft, for only about 26 per cent of the area of the state, it was thought possible to assemble much information to supplement that work. More than a dozen agencies were approached, and an enormous amount of material was obtained. From this it has been possible to prepare maps of the entire state with more or less detail on each mapping unit. The very great diversity of scale and vertical and horizontal control, as well as degree of accuracy attained, has made the attempt much less fruitful than its proponents had hoped. The results have been worth the effort, although disappointing in many respects owing to the fact that the independent agencies operated with no coordination of any sort. The lists of agencies and of material obtained are given in Table I.

TABLE I. MAPPING DATA OBTAINED IN IOWA

SOURCE	MATERIAL FURNISHED
Highway Commission	County road maps 8½ by 11 in. Lake maps State park maps
U. S. Geological Survey	Topographic maps
State Geological Survey (Partly in cooperation with U. S. Geological Survey)	Geologic maps of 60 counties
U. S. Land Office, Department of the Interior	Government township plats, original land survey
U. S. Coast and Geodetic Survey	Various data
U. S. Post Office Department	Post route map for state Rural delivery route maps for each county
Mississippi River Commission	3 sets of maps along river
U. S. Engineer Corps	1 set of maps
Missouri River Commission	Aerial survey
U. S. Bureau of Chemistry and Soils, Agricultural Experiment Station	Soil maps of 80 counties, soil maps of state and of counties on very small scale

OTHER AGENCIES APPROACHED

Commercial Interests: Consulting engineers Large farm interests Insurance companies Railroads Public utilities	County and City Units: County engineers (about one-half) City engineers (few) County auditor's office (drainage maps)

Systematic surveying of the public lands in the public land states was begun about one and a half centuries ago. That operation, still in progress, provided a base map sketched by the surveyors, which probably cost the Government $10 or $15 per sq mile. These maps were a by-product of the nation's attempt to market its public land. The lines run constituted the control system for much of our subsequent surveying and mapping. The maps pictured the public domain as a series of squares, each one like its neighbor except for the theoretical provision for convergence of meridians or curvature of the earth's surface. These maps were topographic in intent and actually gave as good a sketch of the lay of the land as could be expected from a gridiron system of lines crossing each other at intervals of one mile.

Where special conditions were encountered, actual traverses were run to locate and describe the extent and direction of such topographical features as rivers, lakes, mountain ranges, and other natural boundaries. The results of the surveys are readily available in a central office in each of the public land states. They should probably be the nucleus around which to build the proposed information bureaus.

The next great system of surveys was carried out by the railroads. The canals and early turnpike and territorial roads were preceded by surveys and maps, but the railroads crisscrossed the land with very complete strip maps, which were tied into land boundaries because of the acquisition of title. The surveys were based on as many systems of control and datum planes as there were engineering offices, and each part joined another with an equation both in elevation and in horizontal position. With due promptness these valuable maps, profiles, and strip topographic maps were filed away in vaults and pigeonholes and lost to practically all users except the railroads themselves. These railroad maps have more potential value as a basis for a map and surveying information service than many engineers realize. They should be made available in the proposed central agencies.

Another large class of maps which has been frequently neglected as a source of information to save duplication of mapping effort, was prepared in connection with surveys for drainage districts and irrigation projects in various parts of the country. For example, one-fifth of Iowa's 35,000,000 acres is embraced in organized drainage districts and thus has been mapped and tied in to property lines.

The principal handicap to the salvage of such maps in connection with other enterprises is their lack of uniformity in degree of accuracy and orientation and the lack of a common datum. The highway surveys of recent years constitute information of the type which it is contemplated can be assembled in the proposed central bureau. The road surveys by states and local subdivisions are a collection of strip maps covering a really impressive part of the land. Again one of the handicaps to the use of this enormous reservoir of information is the lack of a common datum and system of orientation.

PRESENT GOVERNMENT SURVEYING AND MAPPING AGENCIES

Many Government agencies have built up organizations to make surveys and produce maps to satisfy their own particular uses. These agencies, headed by the U. S. Coast and Geodetic Survey, the U. S. Geological Survey, and the War Department's Corps of Engineers, are the sources to which one naturally turns when in need of survey information. The Geological Survey alone sold 700,000 maps in one year. If the agency to which one turns, however, does not have the map or the information requested, it is all too frequently assumed that such does not exist. Therefore the surveyor is sent out to make a new survey and map when in all probability some other agency has already spent time and money in procuring all, or a considerable part, of the needed material.

There are those who patent their ideas and those who have secret ties to the monuments of their surveys, but these people are not our brothers. How many more are there who will go out of their way to make information available! After all, the engineering profession will not go forward on any selfish road to waste caused by needless duplication of effort.

Naturally there will be instances where the work will be private and confidential, when the surveyor will not care to disclose his purpose by consulting the bureau beforehand, or by divulging his information afterward. This is similar to the professional ethics of the doctor or lawyer, who shares with his colleagues such information as can be used by them without violating the confidence of patient or client.

AN EXAMPLE OF WASTE THROUGH DUPLICATION

In case it is not entirely obvious that there is tremendous waste in the duplication of effort caused by the lack of a state coordinating agency, I will list a few of the surveys recently conducted in one state as prelimnary to various recovery measures. One agency set out to

map all the waste and wooded land in the state. Another sent a force of men over the same area to map possible recreation sites. Another sent out parties to measure and locate possible lake and water reservoir sites. Still another group went out in automobiles to look for possible refuges for wild game. Then along came a regular army of 3,000 men armed with 6,000 field books and 3,000 steel tapes to measure corn–hog compliance in the same area. This was not all. An emergency crew of several hundred men began running a new system of local control preparatory to complete mapping operations, and in the same area a force of Federal surveyors was running its own control preparatory to making a couple of topographic sheets. Then another governmental bureau sent a large force into the state and, ignoring the more than 5,000 local control monuments carefully set out the previous winter, set new triangulation points and bench marks along the railroads, frequently within sight of the other marks. Following all this, another agency actually sent out plane-table parties to map areas for which good topographic sheets were already in existence. Is it surprising that citizens wonder why the roads have to be surveyed so often and accuse engineers of being a wasteful luxury?

A state bureau would stop such overlapping by making full information available in one place. Such an agency could also be consulted by mapping organizations for advice as to the most needed maps and the proper order of procedure for future operations in any program to secure the most in service. At present such locations are chosen on the advice of some single interest, as for example a geologist or a mining group. The Federal Board of Surveys and Maps is working on a plan to secure full advice in each locality before priority of projects is decided.

The central agency, from its knowledge of public demands and available information, could be very helpful in guiding the schedules of future operations. For taxation purposes alone a good map of a state would probably earn the entire cost of conducting such a bureau. The various public works departments of the state would save the cost of such an office many times over in the making of preliminary route and improvement studies.

According to R. S. Patton, M. Am. Soc. C.E., Director of the U. S. Coast and Geodetic Survey:

> As the nation grew, the need for maps grew with it. First came the western flowing tide of migration, which made the latent potentialities of a vast and little known region of ever-increasing importance to our national economy. Then followed an unprecedented industrial and economic evolution, with its bewildering increase in the number, magnitude, and complexity of enterprises concerned with our national domain.
>
> To the latter, the need for maps was particularly great. Unquestionably billions of dollars have been wasted through inefficiencies and extravagances in the conduct of those enterprises, which could have been avoided if the exact geographic data to be derived from maps had been available.
>
> As a single example of this waste, the National Association of State Highway Officials is on record as asserting that if the topographic map of the country had been available prior to undertaking the Federal-aid road projects, the savings to that project alone would have paid the cost of mapping the country.

Up to this time engineers have had no acceptable system of horizontal control for much of the public and private surveying in connection with construction. They will not use geodetic coordinates, and so each separate survey has been based on the land subdivision system of the country. To coordinate these surveys, skilled effort is required, and this would be available only in the personnel of some such central assembling agency as is suggested here.

Today the Coast and Geodetic Survey has prepared tables of plain coordinates for each state in the Union. This system will be used by surveyors as soon as local control survey monuments are available. These systems are tied in to the national triangulation net, and copies are available for distribution in mimeograph form.

For years in many states surveyors have been required by law to file the results of resurveys in a public office of the county. This is surely precedent enough for the proposed plan of asking all mapping agencies, both public and private, to file information relative to surveys in a central public bureau.

OPERATION AND FINANCING OF PROPOSED BUREAUS

Each participating agency would retain full control over its product. The bureau would act as distributing agent and make the output of the surveyor available to others. Sales of maps and copies of notes would be expected to finance the operation of the bureau once it was set up as a general public service. This agency would make all local control information available and would secure its use through proper publicity by radio and press.

The state bureau should be furnished with complete sets of surveys made by, or for, all government departments, including sets of aerial photographs taken by the War Department or other agency for any governmental unit. All state departments should be required to use the available maps in all planning work and should file with the agency notice of intention to make surveys. Prints showing the results of all such surveys should be filed at their termination.

In establishing such an agency, various expenditures would be required for space; filing and counter equipment; desks; chairs; drafting tables; cash register; typewriter; telephone service; working capital for express, freight, postage, and supplies; part of the directors' salary; and the salary of one manager and one clerk. Extra help could be obtained at first, perhaps on a relief basis, using relief funds. It is not intended that this bureau should be a map-making agency, although it should immediately plot the results of small surveys on a master map, which would supplement the standard maps now available for certain parts of some states and all of others.

Now that the Government is about to embark on a ten-year plan to complete the general mapping of the country, the proposed state bureaus are especially desirable to make immediately available whatever maps and survey information are now hidden away in various pigeonholes. These agencies would assist in determining the order and priority of the proposed work and would then become the organizations responsible for the full and complete use of the new maps when ready. The state and local bureaus could be very useful in assisting the Federal Government to secure the most valuable utilization of its mapping activities.

To recapitulate, the present waste and overlapping of effort in connection with surveys and maps is justification for the establishment of a central mapping information bureau in each state. The agency would assist in designating the order in which mapping would be done by Federal agencies; it would provide those who make use of its services with the most complete information possible; it would promote the use of good surveys and maps; and it would save a great deal of money by making present and future information known. Also, in its formative stage, such an agency would provide work for many engineers now unemployed. Such a group of agencies would be inexpensive to operate but indispensable to many enterprises.

Developing the Art of Traffic Engineering

Rapid Progress in Automobile Design Has Created a New Branch of the Profession

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PROBABLY the first "stop-and-go" traffic signal in this country was installed in Cleveland in 1914. Other cities soon became traffic conscious. Now 25 cities and states have an officer designated as traffic engineer devoting full time to the work, and 50 others have part-time employees engaged in it. In 1930 the Institute of Traffic Engineers was founded, a professional society whose 87 members devote nearly full time to this work. No plans for the physical development of a municipality can be made without traffic studies and an analysis of the travel habits of the driving public. Also, a system for the regulation of vehicles must be developed, based on traffic control studies. In this article, a somewhat shortened form of the paper presented before the City Planning Division on January 17, 1935, during the Society's Annual Meeting in New York, Mr. Williams delimits the field of traffic engineering and points out the necessity for this newer branch of the profession.

WHEN roads became something more than trails along which buggy wheels would not sink too far into the mud, highway engineering was born. When highways became something more than slabs of concrete that would hold ten-ton trucks without cracking, traffic engineering was born. In the early days, highway engineers and city planners tended to think of vehicles as static rather than moving, as having dimensions and weight but not velocity and inertia. Horses and buggies were not streamlined, and for them sharp turns and grade crossings presented no serious hazards.

In contrast, traffic today has speed and often heavy volume as its outstanding characteristics. Volume breeds congestion, and speed breeds accidents. Modern traffic is essentially fluid. Like a mighty river it has its coefficients of friction, its eddies, cross currents, and turbulences. Traffic engineering is like hydraulic engineering except that its units are not molecules of water but human beings encased in vehicles of all varieties and vintages.

Heisenberg has explained the "uncertainty" of the electron. Without having any intimate acquaintance with electrons, I would venture to say that their idiosyncrasies are as nothing compared with those of the American driver. Although no one can tell what the individual driver may do, the traffic engineer must and does tell, statistically, what drivers as a whole are doing and probably will do. He must know in advance approximately how many will drive along the Boston Post Road or down Fifth Avenue on a fine Sunday next June between 5:00 and 6:00 p.m., about what percentage will be driving at 30, 40, and 60 miles an hour, and what percentage will make a left turn at a given point. He must forecast how many will run through stop signs as they enter the highway, and how this practice could be prevented by various changes in the traffic signals, the signs, or the police force. That is the work of the traffic engineer—to look upon traffic as a living, moving thing, to put it under the microscope, observe its behavior in sickness and in health, isolate the germs that threaten to infect the whole, and teach it to behave itself. Toward this sprawling body of traffic, so helpless without direction, so potent for death and destruction as well as for business and pleasure, uneducated rather than malicious, the traffic engineer must act as physician, nurse, teacher, and friendly guide.

Before the present century there was no traffic regulation or traffic engineering as these terms are used today. In fact one might begin with the first traffic control or stop-and-go signal at 105th and Euclid Streets, Cleveland, in 1914; with the first traffic signal system in Salt Lake City in 1917; and with the one on Fifth Avenue, New York, in 1920. Another early device was the center line on highways, used soon after 1920. As usual, traffic engineering preceded traffic engineers. That is, work of this sort was first begun by highway engineers, city engineers, city planners, and police officials who little thought what a great oak would grow from the acorn they planted. Pittsburgh established the position of traffic engineer in 1925; Chicago's present traffic engineer started this type of work as early as 1915, although without the title until 1926. It is always difficult to take a census in a field so rapidly changing, but it is believed that today there are about 25 cities and states in which some person has the title of traffic engineer and at least 50 others in which the traffic engineering function is definitely recognized as a part-time position of some one in the city engineering or other city department or in the state highway department, or in which the work is carried on by a part-time consultant. The Institute of Traffic Engineers, founded in 1930, now has 87 members and associates whose work in traffic engineering is near enough to full time to meet the high standards of this small but active professional society.

The functions of the traffic engineer may be stated either in terms of his own activities or of his relations with other engineers and officials. He records and analyzes the volume, accident experience, and other characteristics of traffic in the entire city or state and at particular points that seem to require attention. From such data, through his own experience and that of others, he determines what measures will make the traffic move more smoothly and safely. Such measures may include major street or highway developments; minor improvements, such as repaving or rounding corners; installation of traffic-control devices such as signs, signals, islands, and pavement markings; general or special regulations such as speed restrictions; designation of one-way streets; enforcement measures, such as a greater or a different use of police officers; and educational programs of many kinds. The traffic engineer then advises on the application of these measures if he does not actually execute them. He often installs and maintains the signals and signs, and he may direct some or all of the educational work that is so necessary a complement to engineering and legal efforts.

In the state, the traffic engineer is a member of either the highway or the motor vehicle department and must

work closely with both. In the city he may report to the commissioner of public works, to the city engineer, or to the director of public safety. In either case he must work closely with both the engineering and the enforcement departments and also with the schools, motor clubs, the users of commercial vehicles, the courts, the safety council, and other civic bodies. He must be an analyst, but he must also be a diplomat and a student of human nature. His is the factual approach to the whole complicated problem of traffic, and this includes the human as well as the engineering facts. Engineers who cannot get along with all kinds of people, and enjoy it, belong in some other line of endeavor.

The line of demarcation between the functions of the traffic engineer and those of other officials and organizations is hard to define. It depends, of course, very greatly on local conditions and personalities. The work of the traffic engineer touches that of the city engineering department, the city planning commission or engineer,

STREET CONGESTION DUE TO POOR TRAFFIC REGULATION AND IMPROPER PARKING

the park board, the department of electricity, the police department, especially its traffic division, and to a lesser extent, the schools, courts, and civic organizations.

In general the city engineer or planning commission deals with major street work and also with minor improvements and maintenance, but the traffic engineer should cooperate closely. Although the police department is responsible for direct enforcement it should look to the traffic engineer for information and advice regarding the places, times, and practices on which enforcement should be concentrated, as well as regarding parking restrictions and similar detailed regulations. The traffic engineer should have as much authority as possible in the design, installation, and maintenance of all traffic control equipment. The reports of traffic accidents ordinarily should be filed with the police department, but they should be easily accessible to the traffic engineer and frequently used by him, especially for the analysis of particular localities. These considerations apply equally to the traffic engineering department of a state, except that such a department has the additional function of working in close contact with the municipalities and of advising them in the handling of their traffic problems.

What of the future of traffic engineering? It is safe to assume that in this country there will be a continued increase in highway mileage and widths, in vehicle registration and mileage, and at least no decrease in the power and speed of vehicles—although I cannot but view with alarm the frequent prophecies of automotive engineers that speeds of 100 miles an hour will soon be attained on the public highways. At the least there will be no less need for traffic engineering in the future than there is in the present. The need today has been conservatively described by the Traffic Engineering Committee of the National Safety Council as follows:

> A regularly organized traffic engineering department with one or more full-time men in every city of 250,000 population or more; in cities below 100,000, the definite designation of some member of the city engineering department (or possibly a consultant) to be responsible for traffic engineering work; in cities between 100,000 and 250,000, either the former or the latter, depending on conditions.

There is no lower limit to the size of cities or towns in which some sort of traffic engineering help is needed. Any place that needs a signal or a sign needs professional advice. If there is no local traffic engineer, the need should

NEW TRAFFIC SIGNAL SYSTEM ON MICHIGAN AVENUE, CHICAGO
Traffic on Each Side Controlled Independently

be met by the state highway department, which should make similar traffic engineering studies for all highways outside of municipalities and for all state routes within municipalities, in cooperation with the local officials.

The question arises, can a city engineer, highway engineer, or city planner do traffic engineering work? Certainly, if he will devote the necessary time and study to it. There is nothing mystical or esoteric about traffic engineering. It is the application of standard engineering technic to traffic, the technic of determining first the facts, then the remedies. But it must not be supposed that anyone with general engineering training can give sound advice on a traffic problem any more than such a one could successfully design a sewerage system or a power plant. A considerable literature and a detailed methodology of traffic engineering have already been developed, growing every month through the medium of magazine articles and other publications. With these the practitioner must be reasonably familiar if he is to do a good piece of work. Municipal engineers as well as nontechnical officials must be educated to recognize the special nature of traffic problems and the importance of competent advice in avoiding risk to life and waste of public funds through the use of the wrong equipment or method.

Traffic engineering, itself a special field, is now developing its own specialties, such as the detailed design of controls for signals and signal systems; the special study of certain traffic characteristics, such as speed, in connection with legislation; the detailed design of street and highway signs from the standpoint of driver psychology as well as of optics and practical manufacture; and the analysis of traffic flow in relation to highway advertising. Traffic engineering is still in the grade school if not in the kindergarten. Just how it will develop, no one can foresee. But develop it must if the streets and highways are to be used without intolerable congestion, delay, economic loss, and sacrifice of life and limb.

The Real Property Inventory

A New Tool to Facilitate the Work of the City Planner

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The real property inventory constitutes a new and valuable tool for the city planner. In Cleveland, where the first inventory of this type was worked out, it was found that it contributed materially to the city's recovery from the depression by giving a clear analysis of actual conditions and trends. Since the inception of the plan in October 1932, similar inventories have been developed in many cities of the United States, a special Federal grant having been obtained for this purpose. A paper on the real property inventory, with special reference to Cleveland, was given by Mr. Green on January 17, 1935, before the City Planning Division of the Society at the time of the Annual Meeting in New York, N.Y. This paper is abstracted here.

IT is easy to plan a new city—a city for which streets, boulevards, and main transportation lines may be easily laid out; zoning may be prescribed; parks, playgrounds, and other recreation facilities may be indicated; provision may be made for schools and factories, for water supply, sewage disposal, telephone, gas, and electric services; and the population, initial and ultimate, may be estimated. Everything fits with everything else; it is a static city. But few of us have the pleasure of working with such a city. Our cities are dynamic, and everything in them is constantly changing. Our facilities are either inadequate or more than adequate; our population, sparsely distributed or greatly congested. These factors are to be expected in a dynamic city—they are ever present.

Cleveland, the city with which I have had the greatest amount of experience, has grown from a settlement of 1,076 people in 1830, to a city of 900,429 in 1930. It has increased in population during each decade in the past century. But Cleveland is not an apple starting from a seed and developing into a uniform entity. It is rather like a bowl of cherries, each of which is different.

If the original city had been maintained without annexation throughout the century from 1830 to 1930, it would present an entirely different picture from the original city plus a century of annexation. The original city of Cleveland, with a population of 1,076 in 1830, grew to a maximum population of 9,090 in 1880, and decreased to a population of 1,691 in 1930. Each successive annexation to the city repeated or is repeating this experience. The most important annexations were made between 1870 and 1880. The census of 1880 showed that 28,235 people were living in these recently annexed areas. The population of these areas increased to a maximum of 295,822 in 1920, accounting for 37 per cent of the entire population of the city in that year. Since 1920, however, the population has decreased, and the 1930 population of these annexations was 286,219. The map in Fig. 1 shows the number of annexations that have taken place and the years in which they were first included in the population of Cleveland.

Such changes are not peculiar to Cleveland. Boston and St. Louis have shown similar curves of growth and decay. The Borough of Manhattan experienced its first decrease in population during the last decade, losing 416,791 people, or 18 per cent of its population, during this period. With restriction in immigration, with emigration greater than immigration, with decreasing birth rates and lower marriage rates, American cities soon will have to face squarely the problems inherent in a stable population. In a recent article in *Health News*, published by the New York State Department of Health, J. V. De Porte estimated that the population in New York State in 1970 will be only slightly greater than that in 1930 unless it is affected by interstate migration.

Population by Census Tracts

Although the city of Cleveland as a whole increased in population each decade for a century, some sections showed a serious decrease while in others the increase was spectacular. As described in *Census Tracts in American Cities*, by Leon E. Truesdell and Howard Whipple Green, M. Am. Soc. C.E., published in December 1934 by the Bureau of the Census, one small area, census tract J-1, which in 1910 had a population of 6,114, decreased in 20 years to a population of 49, and in 1934 had 25 people. Another area, T-8, with 59 people in 1910, increased to 10,577 in 1930 and decreased slightly to 10,271 in 1934. Such changes in population involve certain problems. Many of the utilities and services available to the 6,114 inhabitants of J-1 in 1910 were not needed by the 49 people in the tract in 1930 and could not be expected to serve in the least the 10,577 people in tract T-8, six miles away. The chart shown in Fig. 2 gives the population growth of Cleveland.

Other changes are more subtle. Census tract M-7, with 893 persons born in Russia and 393 Negroes, constituting 8.7 per cent of its population in 1920, ten years later found itself with 15 persons born in Russia and 3,150 Negroes, making up 90.6 per cent of its population. This presents new planning problems. Similar changes have been experienced in all the surrounding area and represent changes in property values that it will take years to recognize and adjust.

Dynamic cities may be likened to a busy ant hill in which the ants come and go constantly. With some 300,000 families living in the Cleveland Metropolitan District, the real property inventory showed that 92,000 of these families moved from one place to another during 1933. For example, Lakewood, one of Cleveland's suburbs, lost 1,456 families during 1933. However, during that year other families moving from other parts of the city went to live in Lakewood, this interchange resulting in a net gain of 434 families. Each of the 321 census tracts in the Cleveland Metropolitan District has been studied, and the families leaving each census tract and moving to each of the other 320 have been tabulated. This analysis showed that some areas have stable populations, while the population in others is constantly on the move. For example, for each hundred families living in census tract A-3 in October 1933, there were 106 total movings during the year. This, compared with the experience in census tract SH-3, which had 19 movings per

hundred families, shows extremely different conditions. The environment of the one differs entirely from that of the other, and city plans for the one would be totally unsuited to the other.

DATA BY CENSUS TRACTS IN CLEVELAND

American cities have been satisfied with the enumeration of population and families once in ten years. A new enumeration this year would be interesting, because of the changes wrought by the depression. Cleveland, besides having a running inventory of the families in each census tract, has made a check of the families each October, starting in 1932. This is done through the cooperation of the post-office department, the mail carriers collecting information as to the number of dwellings and other structures. This information includes such items as the number of family units the dwellings provide; the number of units occupied and vacant; the extra families; the number of stores by type; office units occupied and vacant; and a record of other types of buildings and industrial plants and factories.

In January 1934 the Bureau of Foreign and Domestic Commerce conducted a similar survey in 64 cities of the United States. Non-residential buildings were not considered, but dwellings and family units were studied very minutely to provide data on age and condition of property, height of building, and equipment contained in the structure. The standard of living of the inhabitants was also indirectly recorded through data on race, bathing and toilet facilities, lighting and cooking facilities, source of heat by apparatus and type of fuel, number of automobiles, number of rooms, monthly rental or value of property, and all the other items on which information has been so much needed for years.

HOUSING CONDITIONS

As an index of housing conditions in the various census tracts, some items from the real property inventory are extremely useful. Family units without private indoor toilets, those without tubs or shower baths, and those with only cold running water or no running water at all indicate undesirable living quarters. The percentage of old dwellings and the number without basements give some idea of the condition of the buildings. In Buffalo, for example, only 2 per cent of the family units are without private indoor toilets. The lack of this sanitary facility, however, is very evident in several census tracts. In census tract 72, private indoor toilets are lacking in 24 per cent of the family units; in census tract 16, they are lacking in 17 per cent; and in census tract 27, they are lacking in 9 per cent.

In 14 per cent of the family units in the city as a whole, there are no tubs or shower baths, the lack being greater in some census tracts than in others. In census tract 72, this equipment is lacking in 81 per cent of the family units; in census tract 16, in 62 per cent; and in census tracts 28 and 17, in 45 per cent. Although 14 per cent of the family units lack hot running water, most of them have cold running water.

In this city 51 per cent of the dwellings are 31 years old or older. In 15 census tracts over 90 per cent of the dwellings are this old or older, and in 17 others, less than 10 per cent of the dwellings are this old. It has also been found that 23 per cent of the dwellings are without basements. This is a large percentage when compared with the small percentages in other cities for which such data are available: 9 per cent in Cleveland, Ohio; 7 per cent in Worcester, Mass.; and 1 per cent in Providence, R.I. In census tract 5, basements were lacking in 82 per cent of the dwellings; in census tract 4, they were lacking in 78 per cent; in census tract 18, they were lacking in 75 per cent; and in both census tracts 16 and 17, as many as 74 per cent of the dwellings lacked basements. In other census tracts there were no dwellings without basements.

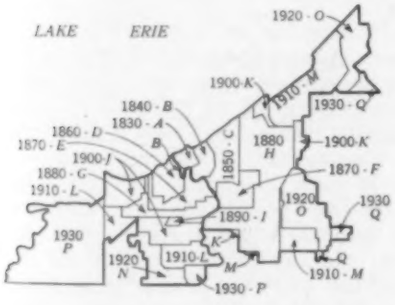


FIG. 1. ANNEXATIONS TO CLEVELAND AND YEARS WHEN THEY WERE FIRST INCLUDED IN POPULATION OF CITY

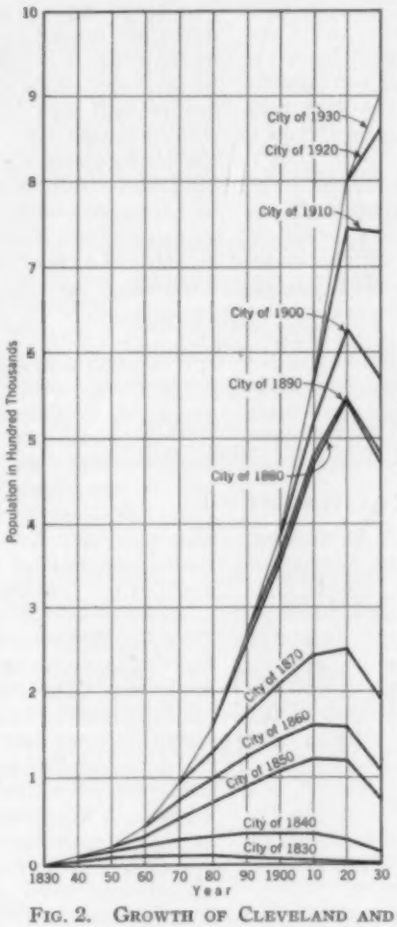


FIG. 2. GROWTH OF CLEVELAND AND OF AREAS WITHIN ITS BOUNDARIES IN SPECIFIED YEARS

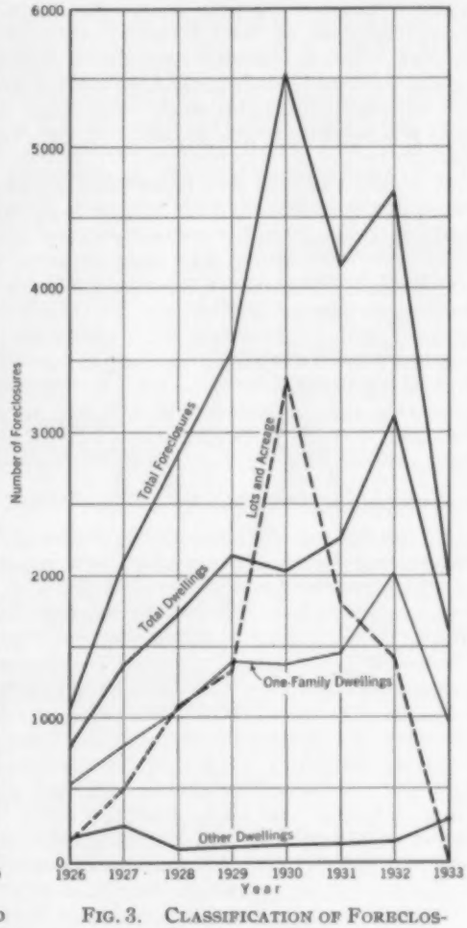


FIG. 3. CLASSIFICATION OF FORECLOSURES IN CLEVELAND, OHIO, IN PERIOD FROM 1926 TO 1933

Thus it is seen that the family units in certain census tracts lack the sanitary facilities and conveniences usually assumed to be an integral part of the standard of living of the American people. The dwellings in these census tracts are old, and it may be assumed that they were inferior even when they were new, since so many of them lack basements.

The Cleveland real property inventory, besides providing data on occupancy and vacancy of dwellings and other buildings, tabulates by census tract the lots created each year; the types of dwellings and buildings constructed and demolished; deeds and mortgages filed and mortgages canceled for the community; and foreclosures by type of property, census tract, and year. In Fig. 3 is shown the number of foreclosures by types of property from 1926 to 1933.

THE REAL PROPERTY INVENTORY

The real property inventory originated at the meetings of the National Conference on Construction, held in Washington, D.C., in 1931 and 1932, through the activities, as committee chairmen, of Raymond T. Cragin and the writer. The reports of these two committees on real estate, as defined in its broadest sense, took the conference by storm; and the sponsoring organizations, the U. S. Department of Commerce and the Chamber of Commerce of the United States, chose Cleveland as the city in which the ideas incorporated in the two committee reports should be tried out. The reason for this choice was the vast amount of statistical data, by census tracts, already available in Cleveland and because both committee chairmen lived in that city. Mr. Cragin was made chairman of the Cleveland committee, and I its director. Dr. Robinson Newcomb, in charge of this work for the Federal Government, was loaned to Cleveland to aid in establishing the work there, and the first real property inventory was initiated in the city in October 1932.

It is said that the first report of the committee, published in the spring of 1933, had more to do with Cleveland's recovery from the depression than any other single endeavor. Presenting the facts relative to the community was sufficient. One organization is said to have profited greatly in the first year by a careful study of the data presented, and an official of a large financial institution has given information making it possible to estimate that thousands of people, who would have lost their homes through foreclosures in 1933 had actual conditions not been so clearly presented in this report, still have their property.

RELIEF LABOR EMPLOYED ON REAL PROPERTY INVENTORY

In the fall of 1933 the Civil Works Administration, recognizing the value of the work, sent a form letter to all city plan commissions in the United States, stating that real property inventories were among the projects on which CWA workers might be employed. Early in December 1933, the Bureau of Foreign and Domestic Commerce obtained a special Federal grant of $2,500,000 to make real property inventories in 64 cities and metropolitan districts throughout the United States.

Additional cities, including New York, Philadelphia, Buffalo, Pittsburgh, Louisville, and others, used CWA labor to gather and analyze similar data, which the Division of Housing of the Public Works Administration and Federal Housing Administration have found of use in making housing plans for American cities.

In Cleveland great importance has always attached to the idea of a continuous inventory, even though it is not as elaborate as the Federal program. Because of this fact, occupancy-vacancy data have been collected for October 1932, October 1933, and October 1934. Other related data for 1932, 1933, and 1934 have been tabulated and analyzed. In many instances these data have been tabulated and analyzed for each year during the past 25 years. The creation of new sub-lots by census tracts, for example, is important; and the classification of foreclosures of property according to type and census tract is even more important. As comparable data become available the value of the real property inventory will be enhanced.

During the winter of 1933–1934 two special studies were made in Cleveland. One of these was on industrial property, including the determination of floor and land areas used by each type of industry; the other concerned itself with the preparation of strip maps for each main thoroughfare, showing type of use, width of frontage, and name of occupant, in order to facilitate a study of the use of the frontage on main business streets. For instance, if gasoline filling stations are located 1,000, 1,100, or 1,300 ft apart on three of the main thoroughfares, it indicates severe over-development.

Such data as these provide a basis for intelligent planning. Suppose that a suburb having a population of 15,181 in 1910, of 41,732 in 1920, and of 70,509 in 1930 has shown an increase of 175 per cent and 69 per cent during each of the past two decades. Questions as to what population the suburb will have in 1940 and what population it will ultimately have can be answered with a high degree of accuracy. The increase of 28,777 in the last decade might be added to the 1930 population of 70,509, giving a population of 99,286. But this suburb never will exceed 75,000 unless radical changes are made in the type of housing and unless single and two-family houses are replaced by apartment houses. If every family unit had been occupied in October 1934, this suburb would have shown a population of 71,400. If the 944 lots were built upon and the 25 acres of unallotted land were subdivided and used, 4,300 more people could be accommodated. Thus a population of 75,700 is the maximum, and it is questionable if that population can be attained in view of the trend to smaller families and lower birth rates, and the present tendency to defer marriage.

DATA OF GREAT VALUE

If such data as are contained in the volumes of the real property inventory, now under preparation, had been available, it is doubtful if the Cleveland Metropolitan District would now find itself with 141,908 vacant lots—nearly as many as have been required for dwellings during the past century. In some of the cities adjacent to Cleveland from 80 to 90 per cent of the lots are vacant, although they front on paved streets and have water mains, sewers, and other facilities representing enormous financial expenditures.

Records of the development of communities—their growth, the movements of population within their limits, their gains and losses in population, the use or non-use of land, and their resources—mean to the city planning engineer what production and sales curves mean to the manufacturer and distributor. There is no use in providing wading pools when the population is too old to wade, schools when the child population is decreasing, or additional telephone conduits when the economic status of an area is declining. It may be expected that the consumption of water and the volume of sewage to be carried away will vary enormously with economic status. During these years of great change, sound indices of trends are imperative for the intelligent direction of the destinies of any community.

New Opportunities for City Planning

Federal Emergency Relief Funds Give New Impetus to Planning Activities

By THEODORE T. McCROSKY

ASSOCIATE MEMBER AMERICAN SOCIETY OF CIVIL ENGINEERS

PLANNING DIRECTOR, YONKERS, N.Y.

WITH the inception of various Federal programs of relief, funds became available for activities, such as city planning, that had been neglected during the early years of the depression. In a paper presented before the City Planning Division of the Society on January 17, 1935, at the time of the Annual Meeting in New York, Mr. McCrosky stressed the fact that city planning can be effectively carried out by work-relief labor. He illustrated his remarks by particular reference to recent planning activities in New York City and in Yonkers, N.Y. This article is an abstract of Mr. McCrosky's paper.

CITY planning boards can now obtain substantial staffs of trained white-collar employees to carry out survey and planning projects under the auspices of the TERA (Temporary Emergency Relief Administration). This makes it possible for local planning agencies greatly to increase their usefulness, which has been badly curtailed during the depression by lack of appropriations for consulting services and permanent staffs.

In the summer of 1934 the National Planning Board reported that only 60 city planning agencies out of 739 had reasonably adequate funds. However, there was compensation for this deficiency in the fact that between 10,000 and 15,000 TERA employees were being hired on planning projects throughout the country. In New York City, the Mayor's Committee on City Planning has over 100 men at work on detailed planning studies and on the graphical analysis of the Real Property Inventory from the city planning standpoint. These men are nearly all architects or engineers. Under the direction of Lawrence M. Orton, of the Regional Plan Association, and F. H. McHugh, they are doing an exceptionally complete piece of work.

In Westchester County, Wayne D. Heydecker, director of the Westchester County Emergency Work Bureau, has organized a very comprehensive county-wide planning project, embracing physical, economic, and social studies. Preliminary reports on a large number of subjects have already been completed.

The Regional Plan Association is helping to organize TERA planning projects in counties and municipalities throughout the New York metropolitan area. Half of the 17 counties have projects under way—the counties of Dutchess, Orange, and Westchester in New York, and Fairfield in Connecticut, being furthest advanced in this work. Good beginnings have been made in Rockland County, New York; and in Bergen, Middlesex, and Passaic counties, New Jersey. The progress being made in planning with TERA personnel is most encouraging, and for the first time municipal, county, regional, and state planning is going forward simultaneously.

Using TERA personnel, the city of Yonkers has made a survey of real estate and tax delinquency, embracing analyses of apartment house rents and vacancies; location of properties on which the city holds the tax

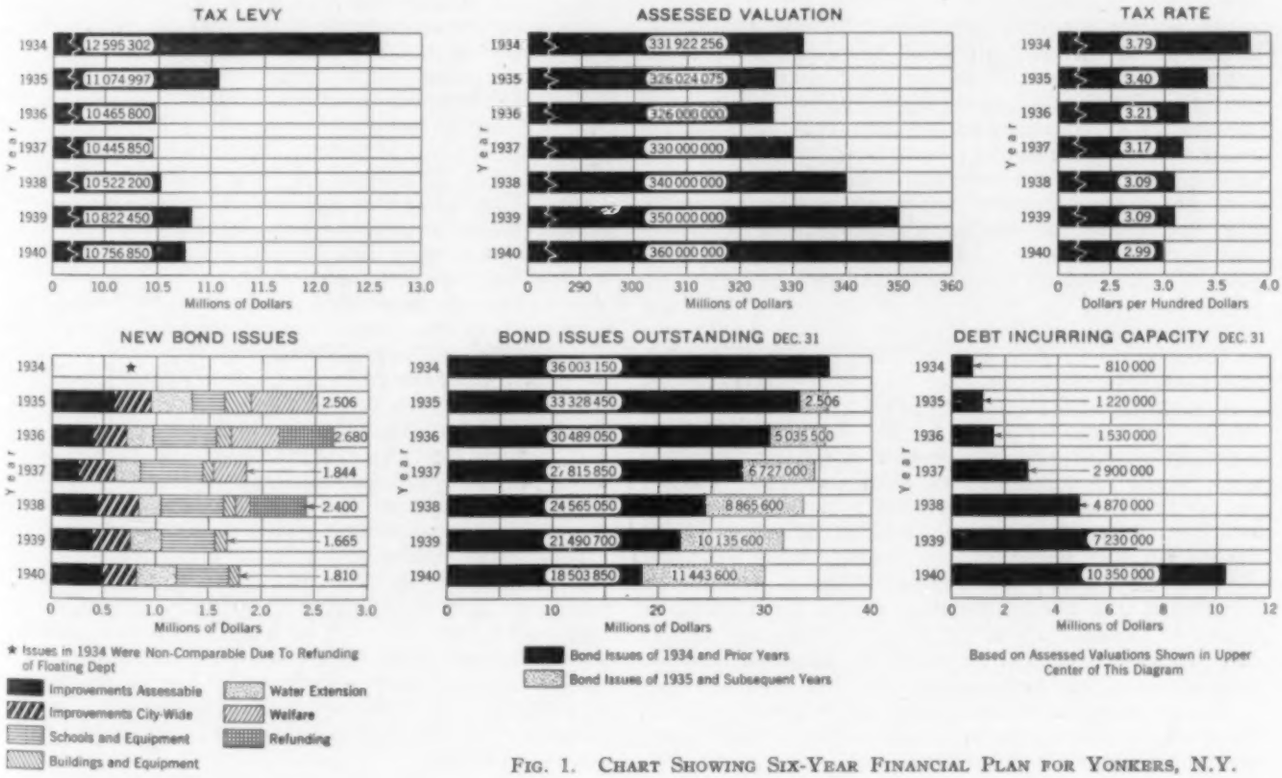


FIG. 1. CHART SHOWING SIX-YEAR FINANCIAL PLAN FOR YONKERS, N.Y.

liens; classification of delinquency by kind of property; and many other financial and economic investigations. A chart showing a six-year plan for financing improvements in this city without placing an undue burden upon the taxpayers is reproduced in Fig. 1.

The first step in undertaking local planning with TERA funds is to convince the local emergency work commission of the advantages to the municipality of assigning qualified relief workers to planning. From the point of view of such commissions, the great advantage of planning projects is that nearly all the expenditure involved is for labor. Appropriations for materials constitute a small percentage of the total expenditure. It should also be pointed out that the studies of the planning board will show the need and lay the groundwork for other allocations of Federal funds. Thus PWA grants can be secured for the construction of sewers and water works, schools, and other public buildings by factual surveys that establish the need for these projects. Similarly, the planning board can make a thorough survey of slum conditions and thus advance the cause of low-cost housing with Federal assistance. The importance of planning has been recognized by the Federal Government, and it will probably become increasingly hard to obtain Federal funds for projects that are not sponsored by planning agencies.

The formal application for funds for projects must give information as to the program that is contemplated, the group sponsoring it, the type of personnel required, the number of workers, the estimated man-hours of work, the allocation required for supplies, and other similar data.

Experience has proved that worth-while results can be obtained with non-technical personnel, if a sufficient number of trained engineers and architects is not available on the relief roll. However, it is very important to have a technical director, particularly during the initial stages of the program. The services of a qualified consulting engineer, on part time, should also be obtained if possible.

The survey program should not be too ambitious. It should be directed primarily toward getting basic information that is essential for later preparation of a city plan. It should include studies indicating the real importance of construction projects that are already under consideration by the city authorities and that may be eligible for Federal financing. Many cities already have city plans. Some of these were prepared prior to 1930 and called for long-term improvement programs that partook of the optimism of the times and were premised on a steady increase in assessed valuation, in population, and in industrial prosperity. With the help of the TERA staff these earlier planning studies can be brought up to date and oriented to the depression and post-despression period.

A carefully considered program for basic survey studies has been drawn up by the Regional Plan Association. It includes preparation of an accurate base map; study of existing street widths, roadway widths, paving types, and dead-end streets; study of accident locations and traffic intensity; and consideration of the need for street widenings, extensions, by-passes, and grade eliminations. The program suggests an analysis of railroad and transit facilities, and a study of other means of transportation. In cities that are not zoned, special surveys should be made of land uses, public property, and park developments.

It also proposes an analysis of school requirements, and of the needs of the fire, police, street lighting, and sanitation departments. Statistical surveys of the growth and distribution of population and of land values are also an important part of the program.

Cities may wish to amplify this program to fit their local needs. In many cases it will be very desirable to undertake a financial survey. This should embrace the study of future financial requirements both for administration and debt service, so as to be able to predict the amount of funds that may be made available for carrying out the city plan. Because of the financial difficulties that our cities have encountered, such a financial survey should also include a thorough analysis of tax and assessment delinquency in order to determine the areas and kinds of property that are most heavily in arrears.

A solution to the problem of finding sites for future public parks and buildings is to be found in the list of tax liens held by the city in question. It is therefore very important to prepare a tax-lien map, from which well-situated properties, long in arrears, may be selected for foreclosure and public use. A particularly thorough study of the distribution of tax delinquency, both lien and non-lien, was made in 1934 by the Westchester County Commission on Government, with Philip H. Cornick of the Institute of Public Administration acting as consultant.

Planning studies made by the TERA must be directed primarily toward fact-finding as a basis for the later preparation of a city plan, and toward substantiation of contemplated improvements eligible for Federal funds. However it is important to remember that fact-finding is not an end in itself. An analysis of the data obtained must be made by the local planning agency, with assistance if possible from a technical director and a consultant. Such an analysis can be simplified by the use of semi-mechanical methods. Thus the Mayor's Committee on City Planning in New York is combining its separate maps of predominant block characteristics—which show such items as use, kind of residence, age, condition, rental, and land value—to determine the areas that have characteristics indicating specific planning needs, such as slum clearance.

As a matter of fact, most cities are in vital need of slum clearance and low-rental housing. The planning commission is the logical agency to make a preliminary survey of bad housing conditions and to present statistics that will lead to the establishment of a duly constituted municipal housing authority. In Yonkers an analysis of more than 125 blocks of substandard housing was made. The blocks were selected not only from the point of view of deteriorated buildings, but for their relation to trends in population distribution, their high tuberculosis death rates, their low land values, and similar factors.

In addition to affording opportunities for TERA planning studies, the present relief programs also provide opportunities for actually carrying out some phases of the plan. Condemned buildings may be razed by TERA labor, and new construction projects undertaken with the aid of Federal funds.

It is likely that the Federal Government's new work-relief program will include construction on a vastly greater scale than in 1934. If this should prove to be the case, the opportunities for slum clearance, street widening, and rehousing will be limited only by the conservatism of our cities and by the vigor with which planning agencies, through their surveys, prove their case for Federal financing of construction in accordance with a sound plan. Such use of Federal funds will prove the economic advantages of rehabilitating our cities and their buildings and will stimulate private initiative to carry out like projects financed by private sources of credit.

OUR READERS SAY—

In Comment on Papers, Society Affairs, and Related Professional Interests

Rôle of the Architect in Bridge Building

DEAR SIR: The article on "Art in Bridge Building" by Mr. Engel, in the December issue, inspires me to comment on the architectural problems involved in bridge work. As Mr. Engel states in his closing paragraph, it is true that the initial concept of a bridge problem is properly the work of an engineer. However, this is true only in so far as foundation, substructure, and superstructure problems are concerned, and it does not necessarily follow that a structure designed by an engineer will possess the elements of beauty, simply because it is functional.

Functionalism as a criterion of appearance has concealed many a questionable design, and its exponents do not seem to realize that instead of being in step with engineering advances they are actually reactionary. It is axiomatic that a bridge should give the appearance of being well proportioned and structurally sound, so that it may be used with a feeling of confidence. Yet a purely functional design may fall short of this requirement. The very strength of a steel structure is its weakness architecturally, for it requires the use of small masses which, in combination with concrete, often mar the appearance. An encased girder bridge supported by shoes resting on concrete columns presents the spectacle of a heavy superstructure supported by ample columns, with the intervening space occupied by a shoe and rocker pin so thin as often to be visually blocked out when silhouetted against the sky. An apparent physical separation of two essential masses results, and the appearance of integrity is destroyed.

While such shoe design has come as a result of engineering advances, it is an obvious fault—so much so that many modern designs place the shoes in column caps, behind pilasters, or in some other obscure location. Today bridges must have a sensible architectural premise based on fundamentals no less important than structural theory. From time immemorial architectural compositions have derived their character from the proper interrelation of masses and lines, and they have always possessed the elements of harmony, proportion, rhythm, balance, and emphasis. They do not result from some caprice of engineering design, nor are they entirely disassociated from such designs. The Memorial Bridge across the Potomac is a sterling example of the successful merging of engineering and architectural principles. Westchester County, New York, offers other examples of such structures.

In many structures the mass of towers, abutments, piers, girders, trusses, and decks gives obvious emphasis to the design at its inception. Nothing is gained through recourse to further realism. Indiscriminate architectural emphasis of an engineering concept is sometimes undesirable. For instance, I have seen continuous concrete-girder spans in a viaduct that appear to be simple spans, and there is no reason for considering such a structure unsuitable so long as it is sound and presents an appearance of strength and stability. I have seen simple, encased, I-beam spans that look exactly like rigid-frame spans, and there are stone-faced rigid-frame structures that appear as arches. These bridges have proved entirely satisfactory, and it matters very little whether or not the engineering scheme is being emphasized. These are the exceptions, and they rightfully demand consideration.

It seems to me that the best interests of the public would be served if the engineer and architect worked in collaboration from the inception of the design. Too often the structural engineer, through some exigency, has had architectural problems thrust upon him; too often bridges have been born of an unsympathetic attitude toward the architectural problem; and too often self-imposed criterions of excellence have led to mediocrity.

ARTHUR J. LICHTENBERG
Bridge Designer, New Jersey State Highway Department

Trenton, N.J.
February 25, 1935

Protection of Water Line

DEAR SIR: A brief description of the experience of one of the CCC camps in keeping its water supply open during sub-zero weather may be of interest. Because of peculiar conditions, it was necessary to run the water intake for this camp above ground, and considerable difficulty was experienced in keeping the line open during extremely cold weather. This situation was handled by using a coal stove with the flue enclosing the intake pipe, as shown in the accompanying photograph. The line was kept open at temperatures as low as 20 deg below zero.

COAL STOVE KEEPS PIPE LINE OPEN IN SUB-ZERO WEATHER

The water intake, which was boxed in and packed with insulating material, was run above ground across a side channel to the main creek, the box being supported on trestle bents. During December flood conditions prevailed, and the pipe line was under water. This soaked the insulating material, which of course froze.

All attempts to rebox and repack the line were of no avail, because the pipe froze as soon as water was pumped through it. There happened to be sufficient flow in the side channel for our purposes, so the intake was set at that point. To eliminate the possibility of freezing, a coal-burning stove was placed where the intake line bent down into the creek. We made a tee elbow of stove pipe and ran it in both directions from the stove, thus covering the water line. A fire was kept going in the stove at all times.

This method proved so successful that the system has been expanded and the line run about 60 ft to the right. This extension was covered in the same manner, and an additional stove was similarly placed at the farther end of the extension.

WERNER C. STRECKER, Assoc. M. Am. Soc. C.E.
Captain, Civilian Conservation Corps, Camp 51

Deposit, N.Y.
March 7, 1935

Arroyo-Cutting Shows Rainfall Cycles

TO THE EDITOR: In the February issue, S. T. Harding, M. Am. Soc. C.E., presents a historical review of lake levels in the West that is helpful to an understanding of the past and to wise planning for the future. A long period of aridity, such as he infers took place prior to the middle of the nineteenth century, is reasonably apt to recur. If and when it does, irrigation systems planned on water supply records of the present century are likely to suffer, a stock population dependent on range lands overgrazed since 1900 may have to be decimated, and our 50 million acres of desert may be multiplied fourfold. Such a period of aridity west of the Rocky Mountains may well have been reflected on the Great Plains just east of them, where school geographies of 50 years ago depicted

"The Great American Desert." Was the conquering of this so-called desert mainly the result of the resourcefulness of the American pioneer, or did greater rainfall play a major rôle?

What of arroyo-cutting in the Southwest, variously attributed to geologic uplift, to decrease in vegetable cover through overgrazing or aridity, to decadence of structures built by prehistoric inhabitants, and to sudden floods and headwater erosion thereafter? Kirk Bryan (*Science*, October 16, 1925) places the date of initiation of the phenomenon at from 1846 to 1890 in various parts of Arizona, New Mexico, and Utah. This coincides with Professor Harding's period of rapid rise in lake levels following centuries of relatively low stages.

The following correlation is suggested: (1) A prolonged period of aridity (ending 1840 to 1850) and low lake levels during which vegetation was at a minimum, valleys aggraded, and arroyos became clogged and filled with superabundant weathered material that decadent ephemeral streams were powerless to remove. (2) A succeeding period of relatively great humidity (ending 1875 to 1880) and rising lake levels during which vegetation increased, streams revived, upland valleys de-graded, and arroyo-cutting began on a widespread scale. (3) A succeeding period of somewhat less humidity (ending 1900 to 1905) during which lake levels were maintained or rose slightly—except where water supply was depleted by consumptive use in irrigation—and upland de-grada'ion and arroyo-cutting continued, receiving fresh impetus at times (1884 for example) by abnormal floods. (4) A succeeding period of renewed humidity (ending 1915 to 1920) during which lake levels rose sharply, despite the use of water for irrigation, and arroyo-cutting continued. (5) A succeeding period, still continuing, of relative aridity and falling lake levels during which arroyo-cutting will subside and upland valleys resume the process of aggradation.

This series of events is illustrated or corroborated by the record youth, maturity, and beginning decadence of Chaco Arroyo near Pueblo Bonito, N.Mex. This arroyo, cut in the aggraded valley of Chaco Canyon, has had a life history of many hundreds of years. Its nearly vertical banks, in layers of varying color and texture, bear mute evidence of alternate cutting and filling in recent geologic time.

The rainfall record at Fort Wingate, 50 miles to the south, shows precipitation 70 per cent above normal during the six years ending in 1873, with 7.6 in. of rain in July (12.2 in. in July and August) 1867 and 11.2 in. in February 1873, truly ample precipitation on which to predicate roaring waters in Chaco Canyon biting deep into its alluvial basement. In 1877 Jackson reports a depth of 16 ft and a width of 60 ft at Pueblo del Arroyo. By 1924, according to Bryan, the arroyo was 30 ft deep and 200 to 300 ft wide. In 1933, careful measurements by the writer revealed no cross section so great as that reported by Bryan, but shoaling and vegetation along the bottom strongly suggested that a filling process had begun, a tendency to become wider and shallower apparently being in evidence. It remains for a long-continued period of relative aridity to witness the clogging and filling of the channel with material stored in the upland alluvial valleys and thus, once again, to complete a physiographic cycle extending over several hundred years.

HERMAN STABLER, M. Am. Soc. C.E.
Chief, Conservation Branch, U. S. Geological Survey
Washington, D.C.
February 20, 1935

Comments on Bridge Construction

TO THE EDITOR: The article by Mr. Engel on "Art in Bridge Building," in the February number of CIVIL ENGINEERING, recalls to my mind a quotation from a book on the construction of iron highway bridges by the late Alfred P. Boller, M. Am. Soc. C.E.

In this work, which was published in 1881 by John Wiley and Sons, of New York, N.Y., he quotes as follows from Ruskin, "Decorate the construction, but do not construct decoration." He gives as an example the Fairmount Bridge over the Schuylkill River at Philadelphia. Of this structure, which was then hardly completed, he says:

"Constructively, this bridge, with its double tier of floors, spanning the Schuylkill in a single stretch of 340 ft, is a monument to its designer and an honor to American engineering. Instead, however, of letting the enormous trusses stand in all their grandeur, depending wholly upon judicious painting and the design of the cornices and railing, etc., for their aesthetic effect, thousands of dollars have been spent in actually covering up the trusses to a great extent with sheet iron, forming an arcade as it were of great massiveness, by arching between the posts of the trusses, the arches springing from large Roman sheet-iron capitals about half way down the posts. The result is that, at a little distance, the spectator beholds an arcade, without any visible means of support for a distance of 340 ft.

"To be thoroughly consistent, the architect (heaven save the name) of this constructed 'decoration' should have at least sanded his sheet iron when painted, and marked out in strong lines the joints that masonry of similar forms suggests."

There is an illustration of the bridge in the book, which certainly makes it very absurd.

C. D. PURDON, M. Am. Soc. C.E.
St. Louis, Mo.
February 26, 1935

Cubic Equations Solved Graphically

TO THE EDITOR: The solution of cubic equations by slide rule as discussed by Mr. Whiteman in the October issue is certainly a practical method, and such a slide rule as he describes can be made very easily. However, some slide rules have a three-logarithmic scale at the top and a one-logarithmic scale near the bottom. There is, for instance, the polyphase duplex slide rule, which can be used by scaling the distance from the value of p to 1 (to the right) and applying this distance from the hair line, using the three-logarithmic scale. Although this is not as convenient as the slide rule described by Mr. Whiteman, values can be solved with a regular polyphase duplex slide rule. Thus there is no need of constructing a second slide rule. Another method of solving cubic equations by the slide rule is given in an article by D. B. Hall on page 54 of the January 10, 1935, issue of *Engineering News-Record*.

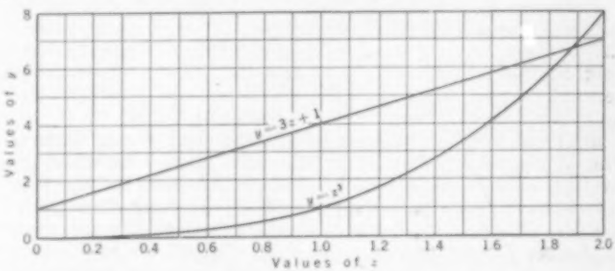


FIG. 1. GRAPHIC METHOD OF SOLVING CUBIC EQUATIONS

In cubic equations when values to two decimals are sought, the graphical method is very rapid. For the solution of the particular example given by Mr. Whiteman, I will describe a graphic method that I have used for several years.

Mr. Whiteman's original cubic equation reads as follows: $x^3 - 12x^2 + 45x - 53 = 0$, which he transforms by letting $x = Z + 4$. This gives the cubic equation, $Z^3 - 3Z - 1 = 0$, which can be written as two equations, $y = Z^3$ and $y = 3Z + 1$. As shown in Fig. 1, the equation $y = Z^3$ may be used in plotting a curve for the solution of any cubic equation.

The equation $y = 3Z + 1$ plots a straight line, and only two points need be located. Connecting these points with a straight line, the value of Z at the point of intersection of the curve and straight line, is found to be 1.88. Then substituting this value back in the equation, we find x equal to 5.88.

For another value of Z we can plot the other branch of the $y = Z^3$ curve. The value of Z will then be -1.53, and the value of x will be 2.47.

Generally in engineering problems involving cubic equations only one positive value is required, and for such cases the graphic method gives a quick solution. Since some engineering problems require the solution of cubic equations, either the graphic or slide rule method should be memorized.

A. W. FISCHER
Pennsylvania Sugar Company
Philadelphia, Pa.
March 8, 1935

Pan-American Highway Feasible

TO THE EDITOR: I should like to comment on the article, "From Panama to the Rio Grande by Highway," by Mr. James in the September issue of CIVIL ENGINEERING. Recently, through the courtesy of a member of the commission appointed to study the proposed project, a copy of a report on the proposed highway was sent me. The first thing that held my attention in this report was the map shown in Fig. 1 of Mr. James' article, in which the heavy black line, representing the route to be followed by the proposed highway, stops just before reaching South America.

At the International Highway Congress, held in Washington a few years ago, there were men from Central and South America who felt that a usable highway extending from the northern to the southern continent would be highly desirable. In his article Mr. James says that such a highway would "... form a substantial part ... of the still greater Pan-American Highway ... to connect all the countries of the western hemisphere." To my way

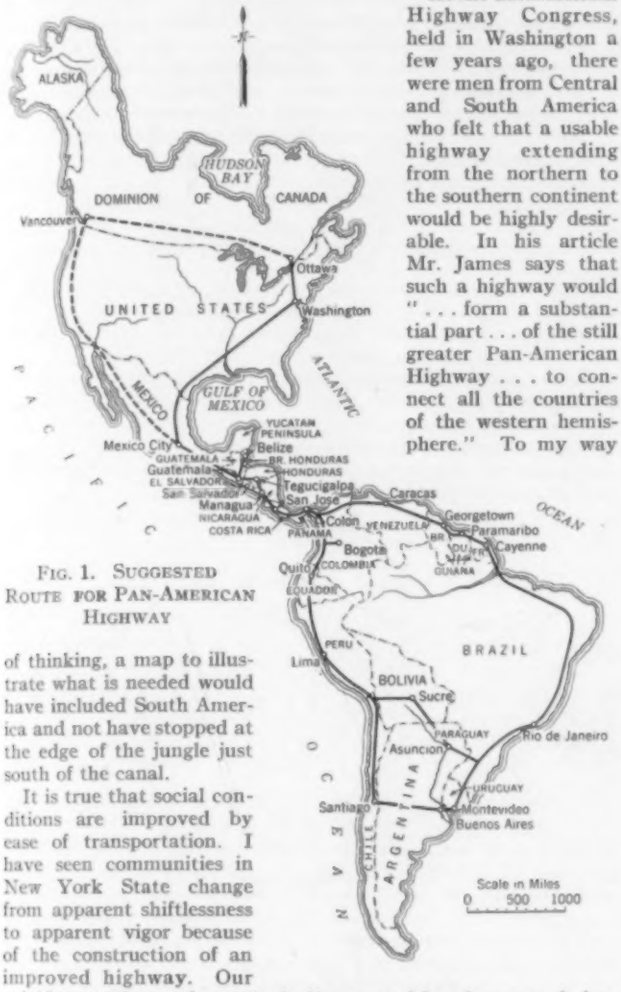


FIG. 1. SUGGESTED ROUTE FOR PAN-AMERICAN HIGHWAY

of thinking, a map to illustrate what is needed would have included South America and not have stopped at the edge of the jungle just south of the canal.

It is true that social conditions are improved by ease of transportation. I have seen communities in New York State change from apparent shiftlessness to apparent vigor because of the construction of an improved highway. Our neighbors to the south are, basically, swayed by the same desires as ourselves. They love and hate, are ambitious and slothful, grave and gay, rich and poor, educated and ignorant, just as we are. Their reaction to better conditions will be the same as ours, and the way to make friends is to be friendly.

It seems to me that objection to an international highway cannot rightly be made on economic grounds. A highway extending from Washington to the capitals of Central and South America would serve to promote friendship and good will, which are more important than the transportation of machinery and cotton. Such qualities are the most valuable commodities that we have and must be sold before those of lesser value. More millions are being spent in the United States today for projects that have no economic justification than would be required to complete a passable motor highway from Texas to Rio de Janeiro, via Santiago and Buenos Aires.

We must not be frightened by the thought of the great cost of a "permanent roadway," because there is no such thing as a permanent highway. The highways and railroads of the United States were not built to last forever. Thus the type of roadway to be provided can be left to the designers. The report previously mentioned takes into account the question of design and also gives preliminary estimates of cost and types.

Several years ago I made the sketch shown in the accompanying Fig. 1 to illustrate a general route for a possible Pan-American highway. The suggested route from Caracas to Rio de Janeiro would probably have to be eliminated at present, and the time when construction south of Cayenne should be considered is so far in the future that it cannot be visualized.

I believe that the Pan-American highway should be constructed at the earliest possible moment and that any money given by the United States to achieve this result would be well spent.

THERON M. RIPLEY, M. Am. Soc. C.E.
Consulting Engineer

Buffalo, N.Y.
March 6, 1935

Blasting Delays in Tunnel Construction

TO THE EDITOR: In Mr. Burkholder's interesting article in the February issue, in which he describes tunnel construction on the Colorado Acqueduct operations, it is noted that a delay of 30 min is still allowed for the clearing out of fumes after each blast. A study of lost time due to blasting delays on large tunnel jobs is most important, and such studies were made on the New Cascade Tunnel in 1926. This was a three-year job with an average of six headings in operation on a 24-hr basis, with three blasts per 24 hr per heading. Allowing a delay of 30 min after each blast, the total loss of time resulting from allowing the fumes to clear away after blasts was nine hours per day.

The usual resistance was met when efforts were made to reduce this 30-min period; it was therefore finally decided to make tests of air conditions in the headings. Safety inspectors equipped with gas masks were sent into the tunnel to sample the air at 5-min intervals, beginning 10 min after the blast and continuing up to an hour after the blast. Two air samples were taken at every time interval. One sample was analyzed by the field laboratory, and one was sent to a commercial testing laboratory in Seattle. The results of these analyses were tabulated, and curves showing the carbon dioxide, carbon monoxide, and oxygen content, at 5-min intervals, were prepared. As a direct result of these tests, the delays after each blast were reduced from 30 to 20 min, representing a saving of about three hours per day or, estimating the six-heading operation for a period of two years, an actual saving of 91 days.

These tests showed that, 20 min after the blast, the headings contained two-tenths of one per cent of carbon dioxide, one-tenth of one per cent of carbon monoxide, and an oxygen content of 26 per cent, which constitute ideal conditions for tunnel headings. It is also interesting to note that, 20 min after the blast, air conditions were very much better than they were 50 min after the blast, due to the fact that trapped gases were liberated when the mucking machine was in the main muck pile. After a 50-min interval, the carbon dioxide content was six-tenths of one per cent and the carbon monoxide content two-tenths of one per cent, while the oxygen content had dropped to 23 per cent.

Naturally the amount of time lost after blasting will always depend to a certain extent on the capacity of the ventilating system used and the climatic conditions at the tunnel site. I do not intend to recommend reducing the delay to an arbitrary 20 min on all jobs, but engineers will find that on large tunnel contracts the practice of testing the air in tunnel headings will materially reduce delays after blasting.

It is noted that, under the heading of "Outstanding Progress Records," Mr. Burkholder has made no mention of the 1,127-ft record established on the construction of the 10 by 10-ft pioneer bore in the New Cascade Tunnel. This record, which was made in October 1926, is for the calendar month of October and not for a selected 30 consecutive days. In this month the greatest 24-hr advance was one of 54 ft made by the same crews that established the record for the month.

R. F. HOFFMARK, M. Am. Soc. C.E.
General Manager, Woods Brothers Construction Company

Lincoln, Nebr.
February 27, 1935

SOCIETY AFFAIRS

Official and Semi-Official

Society's Prevailing Salary Scale Becomes Standard for Public Works

THE SCALE of prevailing salaries for civil engineers, promulgated under the auspices of the Society and described in the August 1934 issue of CIVIL ENGINEERING, has been officially recognized as the standard for use in Federal public works. This development may be acclaimed as a distinct boon to the thousands of engineers in Government employ.

It will be recognized that in collecting the data and in formulating these prevailing salaries, the Society's Committee on Salaries and the Board of Direction had in mind the need on the part of public officials for some guide that might be deemed reliable and authoritative. The fondest expectations of those who sponsored this ideal have now been amply fulfilled.

These rates serve as a guide in determining prevailing salaries for engineers, with which Government officials are required to comply. This is made clear in a letter sent out under date of March 6 to all state engineers of the Public Works Administration, by J. H. Ehlers, Liaison Officer for the Administrator of the Federal Emergency Administration of Public Works. In this letter he states:

"In a few cases it appears that state engineers have permitted professional workers to be paid less than the prevailing salaries as required by P. W. 24294. Salaries for professional and subprofessional employees should be set, as far as possible, in advance of the commencement of work and should be not less than the salaries received by workers on similar work under comparable working conditions. If the schedule of operations appears to require hours of work greater than customary for such employees, that fact may be considered in setting the rate of pay.

"For your information I am attaching a copy of a Report on Salaries of Civil Engineers, prepared by a committee of the American Society of Civil Engineers. This may serve in checking your own observations of the prevailing rate in any locality. It is suggested that you devote the necessary attention to the question of the rates required for professional men under P. W. 24294."

On the basis of this official recognition of the report of the Society's committee, it seems fair to assume that every engineer on public works will receive adequate financial recognition, in terms of current local salaries for engineering employment. This outcome must be a source of gratification to every engineer and a matter of satisfaction especially to the many members of the Society who have had a share in bringing it to pass.

Repaying a Debt

IT WAS Francis Bacon who said in effect that every man is a debtor to his profession. Many engineers have had this consciousness of obligation—the feeling that the profession is larger than any individual, and that it is in essence the sum total of the ideals and accomplishments of its members.

One of the older Society members has gone so far as to state that it is a crime for any engineer to die possessed of valuable knowledge that he has not put into enduring print for the benefit of the profession immediately, and of posterity for all time. Such a feeling seems to be the basis of the general attitude of members who offer papers for Society use. The personal advantage for the time being is forgotten, and the honors or prizes which may accrue are years ahead. Thus genuine altruism impels the conscientious engineer to make his contribution to the general welfare.

Such a feeling was in the mind of a member who recently offered a short paper to the Society with the following statement:

"Ever since my affiliation with the Society I have profited by and enjoyed the articles appearing in the various publications and have hoped that I might some day be able to repay, in part at least, the debt of gratitude I feel to the various contributors and to the Society which makes the publications possible. I have prepared an article dealing with work on which I have been engaged that I believe may be of interest to some members of the Society at least."

A similar thought is uppermost in part of the "obligation form" to which the new member subscribes upon election, through which he solemnly promises that he "will aid the objects of said Society by furnishing papers and discussions." It is to be noted that over 500 members and others sought to repay their professional obligations in part by contributing to regular Society publications issued during the year 1934.

Another State Registration Law

PROGRESS in the registration of engineers is attested by the fact that still another state, New Mexico, was added recently to those that have such state registration laws. With the signature of the Governor already given, this law becomes effective on May 22.

Society members who have been active in this cause will be gratified by the passage of this law in New Mexico, especially since it follows almost verbatim the model law drafted by the Society and its Committee on Registration of Engineers. New Mexico thus marks another milestone in the general advance of engineers towards professional consciousness and idealism.

Tribute to Ambrose Swasey

ON Wednesday evening, February 20, representatives of the Four Founder Societies and the Western Society of Engineers met in Chicago for the presentation of the Washington Award for 1935 to Ambrose Swasey, Hon. M. Am. Soc. C.E., "for his distinguished contributions as a builder of instruments, institutions, and men." Representing the Society on this occasion was Past-President A. J. Hammond, to whom a debt is owing for this description of a most interesting occasion.

In addition to the ceremony of award, one of the happiest features of the evening was the principal address delivered by Dr. Philip Fox, director of the Adler Planetarium and Astronomical Museum of Chicago. Speaking on "Engineering on the Earth and in the Sky," he dwelt upon what we think of as great engineering achievements, such as our long-span bridges, transmission of power, means of transportation by land, sea, and air, and our metallurgical advances in alloys—all as compared with the work of the Great Engineer of the Universe, with his magical distribution of forces, which keep boundless heavenly bodies floating in space, in unison and in fixed orbits. Dr. Fox's brilliant address made his hearers feel what an infinitesimal part of creation they really were. But the finest and most beautiful part was the final word of tribute to his close personal friend of long standing, Ambrose Swasey the man. He said:

"Turn now to him whom we honor tonight, Ambrose Swasey, dweller on earth for 88 years, great in engineering attainments, in production and administration, great in accomplishment, great in breadth of view, great in simplicity and forthrightness, great in sympathies and spirituality, great in appreciation of the essentials and obligations of life, 'maker of machines, institutions, and men,' a very noble gentleman, an engineer worthy to stand in the Washington succession, a worker with hand outstretched and heart aglow for his fellow men; but I know that as he has walked the earth, he has walked with eyes uplifted toward the everlasting stars."

SIXTY-FIFTH ANNUAL CONVENTION, July 3, 4, and 5, 1935, in Los Angeles, Calif.

A New Self-Consciousness Among Engineers

Presiding Officer's Remarks in Opening Joint Meeting to Discuss the Engineers' Council for Professional Development, in New York, March 6, 1935

By GANO DUNN, M. AM. SOC. C.E.

PRESIDENT, THE J. G. WHITE ENGINEERING CORPORATION, NEW YORK, N.Y.

SELF-CONSCIOUSNESS is said to be the critical difference between man and the lower animals; and once it began to develop far back in the dark past, his rate of evolution increased by leaps and bounds until he left them far behind. This evolution, while proceeding to a considerable extent to improve his physical stature, found its principal field in the development of his intellect, of which the crowning products are his style and his spirit, of which in turn the fragrance is his sense of humor.

I see in the Engineers' Council for Professional Development the dawn of a professional self-consciousness among engineers, of which the effects on the engineer's status in society and on his satisfactions in life may be profound. The great branches of the engineering profession have long been organized to a remarkable degree in the promotion of technical proficiency, and each in its stated objectives has turned aside to pay some attention to proficiency of a personal kind.

The high personal standards insisted on from the earliest days by the American Society of Civil Engineers have played their part in influencing the personal standards of the younger societies as they have successively been thrown off by the wheel of time in the enormous growth of the engineering art which has followed in the wake of science and invention. But the principal objects of the professional organizations have nevertheless been technical.

On the other hand, the far scattered diversity of engineering occupations has tended away from, instead of towards, a solidarity of consciousness among engineers and has worked against the conception in the minds of the public, and perhaps often in the minds of engineers themselves, that they are one profession. It is hard for the public to believe that the designer of a great dam and the designer of a telephone circuit are brothers. But such they are in that their way of thinking, or the methods by which they attack their problems, are identical—the methods of Galileo.

When however from these and other extremes of engineering occupation, as represented by the great societies, we see emerging a new centripetal force like the Engineers' Council for Professional Development, resting upon and deriving its strength from the whole profession, it is hard to escape the conviction that there has been born among engineers a new self-consciousness that will do for the profession what the birth of self-consciousness did for primitive man.

Planning for the Annual Convention

SCHEDULED FOR LOS ANGELES, JULY 3, 4, AND 5, 1935

PLANS for the Sixty-Fifth Annual Convention of the Society to be held in Los Angeles during the first week of July are rapidly being completed. The meeting will open on Wednesday, July 3, with the usual official greetings and the annual address of the President of the Society. On Wednesday afternoon there will be a general technical session devoted to the development of the Southwest. This program is now being prepared by the Western Regional Meeting Committee and the Local Committee on Arrangements in Los Angeles.

Thursday, July 4, has been set aside for sessions of Technical Divisions. Although all the plans are not yet definite, it is known that the Construction, Highway, Irrigation, Power, and possibly the Structural and Waterways Divisions will arrange for interesting gatherings.

Details respecting luncheons, dinners, excursions, and other entertainment features have not yet been finally decided but will be reported in detail in succeeding issues of CIVIL ENGINEERING. The final program will appear in the June number.

This Annual Convention will offer an excellent opportunity for engineers to make a trip to the Pacific Coast and combine attendance at a Society Meeting with a vacation that can easily include visits to many engineering and scenic points of interest. Among the engineering projects of particular importance may be mentioned the Boulder Dam, which may be visited en route, and the Golden Gate and Bay Bridge projects in San Francisco. Mention should also be made of the possibility of attending the California Pacific International Exposition, which will open in San Diego, Calif., this spring.

Of particular interest is the arrangement for an organized tour to the Convention. Members will gather from eastern, northern, and southern points at Chicago and travel the remainder of the distance to Los Angeles together. Air-conditioned Pullmans will be available throughout the trip, which will add greatly to the comfort of summer travel.

After leaving Chicago, the party will make stops en route at Colorado Springs, Denver, Salt Lake City, and Boulder Dam—and this probably will be the latest date on which this structure can be visited prior to its completion. The itinerary also includes visits to Zion, Bryce, and Cedar Breaks National Parks in southern Utah. Inclusive prices will be quoted from all points, and a variety of return routes are offered which will enable members to complete the trip at any time and in a number of itineraries.

A sizeable party completed a similar inspiring tour through the Canadian Rockies last summer on their way to the Vancouver Convention. They were most enthusiastic in praise of the exceptional social and scenic possibilities of such a trip. Members interested in joining this group that will travel together to Los Angeles may address the Secretary for further information, and a folder which is now in press describing the tour in detail will be forwarded at an early date.

Conference on Water Conservation at Los Angeles

A CONFERENCE of foresters, investigators, agriculturists, and engineers, called by the Committee on Conservation of Water, of the Irrigation Division of the Society, under the auspices of the Los Angeles Section, was held in Los Angeles on March 13 and 14, 1935. A most interesting and helpful meeting resulted. The history, study, and scope of water conservation were outlined in the preliminary address by A. L. Sonderegger, M. Am. Soc. C.E., chairman of the committee. His remarks are here given in slightly abbreviated form.

OPENING STATEMENT BY CHAIRMAN

"Five years ago the Committee on Conservation of Water, of the Irrigation Division of the Society, called a conference of engineers, foresters, agriculturists, and investigators for the purpose of discussing some of the problems pertaining to the conservation of water supplies. It had come to the knowledge of the committee that many agencies, governmental and others, as well as engineers in private practice, were occupied in investigations relative to the watershed, the conservation of water, and its economic use. The conference brought about an interesting exchange of opinions and ideas and no doubt was instrumental in the initiation of new lines of investigation.

"It was realized that the watershed and the conservation and economic use of water are the common problems of the forester, engineer, and agriculturist and that cooperation in scientific research, as well as in the evolution of methods for the practical application of water, is an essential element in the economic development of the semi-arid Southwest.

"During the past six years much has been accomplished along the line of water conservation and kindred problems. The Committee on Conservation of Water therefore deemed it appropriate to call another meeting which would establish the progress made and enumerate the new problems that have arisen, particularly regarding the control of erosion, both in the mountain watershed and the plain, and the necessity for reliable information on run-off, peak flow, debris production, and transportation from the mountains to the sea.

"Extensive investigations have been carried on by the Bureau of Agricultural Engineering, U. S. Department of Agriculture, relative to the utilization of water, such as studies of evaporation, rainfall penetration, consumptive use of water by native and agricultural crops, economic use of water for citrus culture, soil erosion, and silt, cost of water, pumping for irrigation, water spreading, and laws affecting water rights to both surface and ground water. Research on the water requirements of crops and orchards has been

of great assistance in the recent period of drought, which in many instances reduced water supplies to the minimum necessary to maintain the existence of plant life.

"The California Forest Experiment Station has launched an extensive research program in the mountain watershed on the distribution of rainfall, on the consumptive use of water by forest cover, and on run-off and erosion for natural conditions, for areas denuded by fires, and for cut-over areas.

"Recent floods have brought to the foreground the subject of check dams in Southern California and their function in the conservation and control of flood waters. Thousands of such dams have been built and large sums expended. A discussion of this subject and an expression of opinion by the conference as to the practical value of such structures appear to be of general interest.

"In the solution of flood-control and conservation problems, the determination of the run-off from small units of both mountain watershed and plain, and the volume of debris production occasioned by severe storms, is a matter of increasing importance. The practical value of the "rational method" in the determination of run-off is generally recognized. Experiments with small test plots, as initiated by the Miami Conservancy District, have been carried on in Southern California by various agencies.

"We hope to make the results of our labors available to the public in concise form; also to outline and recommend further research work relative to the conservation of water."

AN INTERESTING PROGRAM

Following the chairman's address, the conference entered upon a series of four sessions, embracing a wide variety of subjects presented by a brilliant series of experts in the various special topics. The most complete program included such questions as "Evaporation Studies in Southern California," "Use of a Limited Water Supply for Irrigation on Agricultural Lands," "Law of Underground Waters," "Economic Limits of Conservation of Flood Waters," "Run-off from Small Experimental Plots," "Measurements of Debris Transported from Burned Areas," "Erosion Control," "Check Dams," "Safeguards on Denuded Watersheds," and "Erosion and Run-off Experiments," including both mountain areas and cultivated lands.

Starting on Wednesday morning, March 13, 1935, the conference continued in morning, afternoon, and evening sessions until Thursday noon. Approximately 200 were in attendance, including delegates from the counties surrounding Los Angeles, the San Francisco Bay region, Sacramento, and a few from other states. A set of resolutions was passed upon by the conference relative to various features of water conservation policies and recommendations for further investigations. As a conclusion to the conference, there was a trip to the San Dimas Experimental Forest of the California Forest Experiment Station, U. S. Forest Service, attended by perhaps 75 people.

It may be feasible for the Society later to publish certain of the papers presented at the conference, at least in condensed form, thus bringing to the membership at large some of this valuable technical material.

Freeman and Horatio Allen Scholarships Open

ATTENTION is again called to the fact that both the Freeman Traveling Scholarship and the Horatio Allen Scholarship at Columbia University are to be awarded by the Society during the current spring. Notice of the Freeman Scholarship for travel in Europe has been given previously and a number of applications have been received. If there are others who wish to apply, they should do so immediately so that the committee will have time for a careful study. Those interested should consult the *Year Book* for details or, better still, should write to Society Headquarters for blank forms and all necessary information.

Notice is also given of the availability of the Horatio Allen Scholarship for the college year 1935–1936. Although this scholarship is provided by Columbia University, the award of it rests with the Society. Horatio Allen himself typified the best of the two institutions, being a graduate of Columbia in 1823, and later, by virtue of his eminence in the civil engineering profession, one of the early Presidents of the Society.

In general, the award is intended for outstanding young students who either are graduates of approved schools or have a record of at least two years of creditable undergraduate experience. Upon certification by the Society's Committee on the Columbia University Scholarship and approval by the Columbia University authorities, such a student is awarded this valuable prize. Reappointment may make the scholarship continuous up to three years in all, depending on the undergraduate record of the candidate and the studies available for completion of his work. In money value this scholarship is worth $400 or more.

Applications for these scholarships must be submitted by June 1. Preferably, however, they should be sent in as much earlier as possible. Inquiries addressed to Society Headquarters will bring the necessary detailed information.

Old Friends

A LONG and continuous period of affiliation with the Society means a great deal to the Society as well as to the member. The records kept at Headquarters always show just which members have had the longest connection. Because there are "no friends like old friends," a special honor attaches to the following list. The names of these 25 members of longest standing have been arranged chronologically, with the date when they first joined the Society:

Robert Fletcher	November 4, 1874
Frederick Billings Howard	March 3, 1875
Caspar Wistar Haines	February 2, 1876
Henry Newton Francis	March 1, 1876
Charles Emery Billin	April 5, 1876
Frank Ormond Whitney	May 3, 1876
William Covington Gunnell	February 7, 1877
C. Frank Allen	February 6, 1878
Percival Roberts, Jr.	May 7, 1879
Charles Louis Strobel	December 3, 1879
George Herndon Pegram	April 7, 1880
George Hume Simpson	October 6, 1880
John William Ferguson	January 5, 1881
Walter A. Doane	September 7, 1881
John Alexander Low Waddell	October 5, 1881
Onward Bates	January 4, 1882
Gustav Lindenthal	May 3, 1882
John Francis LeBaron	June 7, 1882
George Edward Thackray	September 6, 1882
Charles Frederick Loweth	January 3, 1883
Hunter McDonald	April 4, 1883
Frederick Newton Willson	September 5, 1883
Henry Frederick Juengst	April 2, 1884
Henry Goldmark	May 7, 1884
Samuel C. Weiskopf	May 7, 1884

It will be noted that among these eminent engineers appear the names of four out of the fifteen living Past-Presidents of the Society, including the two oldest in terms of presidential service.

All honor to this distinguished group, who by faithful service and personal integrity have brought lasting fame to the Society. Their names and records are an inspiration to their fifteen thousand fellows.

"Year Book" for 1935 Progresses

FOR A NUMBER of weeks intensive work has been going on at Headquarters in connection with the publication of the 1935 *Year Book*. Items concerning Society affairs have been brought up to date, changed, or added to as circumstances required.

Mainly, however, the work has been in connection with the alphabetical and geographical lists. All corrections up to March 1 are being included in order to ensure that the register will be complete and up to date. Galley proofs are read and corrected, insertions are indicated in the proper places, and finally the page proof is similarly scrutinized. No stone is left unturned in this effort toward completeness and accuracy. As this issue of CIVIL ENGINEERING goes to press it is too late for any further corrections of these records to be made in the *Year Book*, but it is sincerely hoped that members have already forwarded all corrections desired. Thus the 1935 *Year Book* should reach the usual high standard.

In preparing for the publication of this volume, estimates of size, weight, container, and all other materials and expenses were made.

It was therefore disconcerting to discover at the last minute that the *Year Book* actually was about a dozen pages longer than had been anticipated. It finally developed that no mistake had been made in estimating the number of items but that their average length was greater, which accounted for the difference. So many members are employed on Government work that the listing of the various commissions and authorities on which they are serving has required more space than usual in the *Year Book*. This was an entirely unexpected development and caused difficulty in another direction.

The order for paper required, which likewise had been carefully estimated, was found to be insufficient. As a matter of fact, code requirements permit some latitude, either over or under, in the filling of any paper order, and fortunately in this instance there was an overrun, which proved sufficient to take care of the added pages. In all, about 6,000 extra sheets of a size approximately 38 by 50 in. and weighing in the aggregate more than 700 lb were needed.

Mailing of the 1935 *Year Book* will be made jointly with the April issue of PROCEEDINGS. These two volumes, labeled, respectively, Part 1 and Part 2 of PROCEEDINGS, will be sent on April 15, 1935, to every Society member on record.

Financing Research

THE SPLENDID work that is going on year after year under the auspices of the Engineering Foundation can best be appreciated by a brief glance at its financial statement for 1934, as incorporated in its annual report.

Resources:	*Summary*		
Balance January 1, 1934		$11,202.75	
Receipts:			
Income from endowment and temporary investment of income balance	$43,447.90		
Income from minor items	613.48	44,061.38	
			$55,264.13

Details of Expenditures

Research Appropriations:			
Concrete and Reinforced Concrete Arches	$1,500		
Earths and Foundations	1,500		
Alloys of Iron	5,000		
Barodynamic Research	2,000		
Effect of Temperature on Metals	3,000		
Wire Rope	1,250		
Thermal Properties of Steam	1,000		
Cutting of Metals	1,500		
Mechanical Springs	1,000		
Riveted Joints	500		
Electric Welding—Pure Iron Electrodes	890		
Engineers' Council for Professional Development	412.66		
Engineering Career Pamphlets	33.75		
Personnel Research Federation	500		
Plastic Flow of Concrete	1,200		
Engineering Index Investigation	400		
		$21,686.41	
Promotion of Research and Administrative Expense		$11,796.58	
Total for Furtherance and Support of Research			$33,482.99
Balance January 1, 1935			$21,781.14

The report notes the interesting fact that from its organization through December 31, 1934, there passed through the Foundation's account money contributions from organizations and individuals, for specific activities, totaling $228,607.75. Detailed reports of the Engineering Foundation are on file at Society Headquarters and may be consulted by anyone who wishes further information.

Society Emissaries

DURING the month just passed a number of trips, independent yet coordinated, have taken Society officers throughout the eastern part of the country. President Tuttle and Secretary Seabury together have traversed the states on the Atlantic seaboard, making stops for the two-day joint meeting of the Student Chapters of Virginia at Virginia Military Institute at Lexington, Va., and for a meeting with local members at Atlanta, Ga. At the same time Mr. Jessup, the new Field Secretary, has been making his first tour among the Local Sections, visiting the Local Section at Milwaukee; the Student Chapter at the University of Wisconsin at Madison; the Local Section and the Washington University Student Chapter at St. Louis, Mo.; and the local members at Baltimore. He will then join the President and the Secretary at the Virginia Military Institute and at Atlanta.

The President and Secretary in visiting the various local groups told of the increased activities in the past four years, whereby the Society has intensified its work with respect to employment and reemployment of engineers; to the compensation to be accorded them; and to the many contacts made by the officers, committees, and selected members of the Society, with the Federal administrative officers in every department in which civil engineers are employed or where their services may be required.

On the other hand, Mr. Jessup's trip is of an exactly opposite character. His duty for the moment is to establish intimate relationships with the leading members of the Society in every city which he is to visit and to seek from them the consensus of opinion locally as to the problems which the Local Sections have and the activities which they might undertake either through their own initiative or with assistance from Society Headquarters. His further effort is to develop a crystallization of the local attitudes toward registration of engineers and, as far as practicable, to help to organize them in their efforts to obtain the registration of engineers.

FACILITIES OF RONEY PLAZA CABANA SUN CLUB AT MIAMI, FLA.
Available to Members of Society at Miami Meetings, April 3–6

This is particularly true of the situation in Missouri, where for several years this matter of registration has been presented to the Legislature but where the effort hitherto has been unsuccessful. Similarly, it is true at Baltimore, where a division of opinion exists as to whether the registration of engineers is or is not desirable. Mr. Jessup is also making inquiry in the cities which it is possible for him to visit as to the extent to which there appears to be a plan to break down the Civil Service provisions with respect to those in the employ of either the state or the municipalities. This procedure, in general, consists of a shifting of expenditures from the municipality in terms of the normal and equitable salaries of its Civil Service employees over to the Federal Government, by which work of perhaps identical character may be carried on as a relief project with engineers employed at relief salaries and under other relief restrictions. His observations will be available to the Board of Direction in connection with its procedures which are in mind.

At the same time that these activities and inquiries have been going forward, Mr. Richmond, Assistant to the Secretary, has made an official visit to the Puerto Rico Section where he has informed members of what the Society is doing; of its activities along the lines of research; of the details incident to the volume of technical material developed at meetings and distributed to the membership in the publications; and of the participation by the Local Sections in making effective locally the rulings and procedures which have been urged upon the Federal authorities at Washington with respect to Public Works under the PWA and the FERA and the mapping programs carried on by the U. S. Coast and Geodetic Survey. In general, he has been giving them an idea of accomplishments which, directly or indirectly, are made available to members through the Society's facilities afforded by dues and the other sources of income.

These various trips have been so arranged that they will converge at Miami, Fla.—which Mr. Richmond will reach by air—in time for the Board meeting on April 3 and 4 and the Nineteenth Annual Meeting of the Florida Engineering Society to follow immediately. For this meeting a varied program has been arranged, including many topics of a civil engineering nature. President Tuttle is scheduled to address the session on Friday, April 5, on the subject of coast erosion problems. The American Shore and Beach Preservation Association is also joining officially in the Friday meeting.

To complete the record for the year so far, mention should also be made of previous trips of President Tuttle and the Secretary to attend the Annual Meeting of the Northeastern Section at Boston; and the Annual Meeting of the District of Columbia Section at Washington, D.C. The Secretary also has visited the South Carolina Section, at the time of its annual meeting, held jointly with the South Carolina Society of Engineers at Columbia, S.C.; the Annual Meeting of the Engineering Institute of Canada; the Engineer's Club of Philadelphia; and the Philadelphia Section.

By these many contacts, pleasant in themselves, members of the Society and the officers of the Local Sections are afforded the opportunity of close intimacy with the general activities of the Society and the more specific efforts constantly being made to improve the relationship of civil engineers with the present procedures going forward under so many of the Federal agencies both permanent or more or less temporary.

Ramifications of a Secretary's Work

EVEN for those in close touch with the administration of the Society, it is difficult to realize how many activities are being carried on jointly with other societies through agencies established to accomplish one or another definite objective. For the first time the whole story in regard to these joint activities will be presented to the officers of the several societies at a meeting scheduled for May 20. But perhaps an idea of the extent of this type of work may be gained from an outline of the offices held by the Secretary of the Society as its official representative in organizations carrying forward such joint activities.

The recent gathering of names and addresses of engineers for the purpose of making a survey of the engineering profession is a case in point. As noted in detail in the March issue, more than 210,000 cards 3 by 5 in. in size were secured and subsequently sorted and arranged alphabetically according to place of residence. This extensive task devolved upon the Society as a duty because its Secretary is the chairman of the Committee of Allied and Technical Professions of the American Engineering Council.

From time to time the work of the Engineers' Council for Professional Development has been described in these pages. In these first two or three years of its existence, it has developed an enormous amount of correspondence, and gatherings of committees, subcommittees, and other administrative units have been frequent. The fact that the Secretary of the Society has been also secretary of this Council since October last, has added to the regular work of the staff a large amount of incidental letter writing, answering of questions, and formulation of procedures. This is done jointly with the staff of the American Society of Mechanical Engineers.

For many years Dr. Calvin W. Rice, Secretary of the American Society of Mechanical Engineers, was chairman of the National Committee of the Engineering Societies Employment Service. On his death in October 1934 he was succeeded in the chairmanship of that Service by Mr. Seabury, who for ten years previously had been its treasurer. Thus still further demands were made upon the Society's staff. The work involves continuous study of the relations of the three employment offices, located at New York, Chicago, and San Francisco; contacts with the societies that are collaborating with the Founder Societies in the support of these offices; financial details; continued observation of the ways in which these offices of the Employment Service have been and can be of service in the reemployment of engineers under the Federal Emergency Program; and various related matters.

Organized in 1931, the Construction League of the United States is an assembly of national associations interested in construction. It includes the national organizations of the architects, engineers, general contractors, special contractors, and materials producers and fabricators. Representatives of these organizations meet, usually at Washington, where an office is maintained in charge of an assistant secretary under the guidance of a joint secretariat. The Secretary of the Society is a member of this joint secretariat together with the secretaries of the American Institute of Architects and of the Associated General Contractors of America. The Construction League has provided a forum for the friendly discussion of such difficulties as may arise between the different elements of the construction industry and has been interested in every movement related to housing, public works, and other Federal construction activities.

Of somewhat less immediate concern in these times of unemployment of engineers is the management of the Engineering Societies Building, in which the four Founder Societies have their headquarters. The Secretary of the Society acts as a member of the House Committee of the Real Estate Committee. He is also a representative of the Society on the Division of Engineering and Industrial Research of the National Research Council. He is a member of the Library Committee, which has charge of the administration of the Engineering Societies Library housed in the Headquarters building. Moreover he is expected to attend all the meetings of the United Engineering Trustees, Inc., which is the fiscal agent for the Founder Societies with respect to their joint real property and to the funds of the Engineering Library and the Engineering Foundation.

Obviously these meetings and conferences, which are of almost daily occurrence, may and frequently do, conflict. In such cases the Secretary's place is taken by the Assistant Secretary, Mr. Beam, by the Manager of Publications, Mr. Wilmot, or by the Assistant to the Secretary, Mr. Richmond.

A direct and intimate relationship is thus established between the Society and the agencies that have been set up to pursue specific aims in behalf of the societies jointly. This permits the informal use of these agencies on a great many occasions for the handling of those special matters that come up suddenly and may be influential in advancing the engineering profession.

In these times the American Engineering Council is particularly valuable in this respect. Complaints or other matters calling for remedial action, more particularly at Washington, when through some channel they reach the ears of those at Society Headquarters, are at once forwarded to the Council, which carries them to the proper administrative officer at Washington. This is done by letter, wire, or telephone with the least practicable loss of time and in the way best calculated to secure results. Matters requiring more intimate or more detailed attention may or may not be routed solely through the office of the Council. This depends on their complexity or on some other factor, which may call for a sudden trip to Washington on the part of the Secretary or of the President of the Society. Frequently also such work devolves on a selected member of one of the Society's many committees, to which may have been assigned some specific task in connection with a problem involving long and detailed negotiation.

Program for Publicity in Preparation

FOR A number of years the Society has had special committees dealing with the question of helpful publicity for the Society and for civil engineering and civil engineers in general. Under the title of Committee on Public Education, these groups have been very active in examining all the many possible outlets and best methods of approach. Thought has been given to newspaper articles, syndicated items, Associated Press news, radio talks, and other methods.

In spite of the fact that the absence of funds has been a great handicap, the Committee on Public Education has done excellent work in exploring the field and making definite recommendations. Its work is now about to become more directly useful to the Society.

Included in the Report of the Committee on Aims and Activities, submitted to the Board of Direction in January, was an item advocating "prompt initiation of a program of publicity." Responsive to instructions from the Board to this effect, the Committee on Public Education has been active. A number of meetings and conferences have been held and members of the committee have independently investigated a number of excellent leads. Abel Wolman, M. Am. Soc. C.E., is directing this work as chairman of the committee, and no line of approach is being overlooked.

As soon as a definite program has been adopted, it is expected that an aggressive but dignified campaign of publicity will be initiated, yielding prompt and worth-while results.

American Engineering Council

The Washington Embassy for Engineers, the National Representative of 222 National, State, and Local Engineering Societies Located in 41 States.

PUBLIC WORKS IN PROSPECT

The work relief bill, after weeks of deadlock, again moves toward enactment with its $4,880,000,000 fund for projects throughout the country. Each phase of the program earmarked in the present draft of the bill is essentially an engineering job. Highways, streets, grade crossing work, housing, rural electrification, sanitation, soil erosion control, and other items all have employed large numbers of engineers in earlier stages of the emergency program. The function of the engineer has become increasingly recognized in these works so that the expansion of technical staff, both in Washington and in the field, after the bill passes, is a pre-arranged certainty. In addition, a special item of $300,000,000 goes to projects for professional and clerical people. Any small fraction of such an outlay will mean a great deal to the jobless engineers.

Who runs the program is a question lost to view in the political melee. But the more aggressive Federal units, regular and emergency, have been putting to paper in considerable detail the things they want to do when they have the money. The American Engineering Council has been working with some of these planners. In the scramble for precedence after the bill passes, all may not obtain their desires, but certainly all cannot lose.

Jobless engineers are at a disadvantage in seeking placement under the program until it is revealed just which agencies will handle the various projects. Present steps may include registration with the nearest U. S. Employment Office; securing of political endorsements from County Chairman upward; filing applications with Federal agencies in Washington or in field offices. Civil Service examinations involve more remote possibilities; but even such chances should not be overlooked in times like these. Interested members should inquire at post offices or write the Civil Service Commission, Washington, for lists of pending examinations.

The Holding Company Bill, as now phrased, tends to extend Federal jurisdiction over the practice of engineering under contract with utility firms, according to a resolution by the American Institute of Consulting Engineers, asking the Council to intervene.

The plan for public affairs committees of the Council in each locality may be accelerated in cities having sections of national engineering societies. The sections may appoint representatives on a central committee to handle matters of joint interest.

PROCEDURE AS TO LEGISLATION

With so much of engineering interest at stake in the current session of Congress, it seems timely to summarize the policies and methods followed by the Council in legislative matters. The staff has for its guidance:

1. Policies adopted by the Assembly and Administrative Board at annual meetings.
2. Advice on new matters from special and standing committees.
3. Precedent of several years on matters which do not require new rulings.
4. The viewpoint of public interest as a fundamental reason for participating in legislative activities.
5. The corollary viewpoint of advancing the economic status of the profession.

The factors of public interest and the status of the profession are closely related in problems constantly arising in connection with the federal program due to the extraordinary relation of government to business at present. It is fundamental that competent engineers must be employed where engineers are needed if the public interest is to be protected against faulty planning and wasteful execution.

Although the "Washingtom Embassy" of engineers may not jump into drastically new lines of action in the name of the profession without due consultation and approval, it is not hemmed in by ponderous procedure. The precedent set in past work, recognized as in the interest of the profession, gives sufficient latitude for quick action on immediate, practical steps and leaves only the long-range phases for more deliberate action.

Legislation which the Council follows for engineers includes the following general categories:

1. Construction—Federal appropriations and administrative machinery for construction. (The work-relief bill.)
2. Development of industries—Amendments to the National Industrial Recovery Act, new patent legislation and similar matters.
3. Development of natural resources—Bills relating to water power, navigation, reclamation, soil erosion control, surveys and maps, and similar public activities wherein the engineer serves in the development of "our national plant."
4. Engineers' welfare—General legislation in the field of unemployment insurance and old-age pensions; bills such as Civil Service measures and engineers' compensation on Federal and relief work, more directly affecting the engineer.

Scores of bills under each of these headings are under consideration. With its limited staff, the Council is obliged to concentrate on those of the greatest importance to the profession. Where needed, information and arguments are presented to congressional committees in open hearings or otherwise. The Council fills frequent requests from Federal agencies setting up programs along engineering lines for information as to features of concern to the profession. The Public Affairs Committee and its subcommittees are sent copies of important bills and documents and are kept generally informed. By expanding the scope of this news letter, it is hoped to give the profession at large an increasingly clear and comprehensive account of the situation.

ECONOMIC AND PROFESSIONAL MATTERS

The National Bureau of Economic Research, in whose work the Council is a cooperating agency, reported noteworthy progress and good financial condition at its annual meeting last month, attended by Mr. Feiker. Recent studies include incomes of consulting engineers, physicians, dentists, and lawyers. Tables will summarize gross and net income for each profession, the differences in towns of various sizes, and other factors. A new report on public works in relation to the national economy has been prepared by Dr. Arthur D. Gayer. Detailed information on this and other important topics may be secured by writing the Bureau at 1819 Broadway, New York, N.Y.

The mapping program still is in line for favorable action when the works bill passes. The U. S. Coast and Geodetic Survey is continuing its PWA work in full force through the fiscal year and still has more than 2,000 men under the ERA. An item of $28,000 for seismological work in California is in an appropriation bill, two-thirds from Federal funds and one-third to be made up by the state.

ACTIVITIES OF THE COUNCIL

Council's new membership plan has definitely brought in the Engineers Club of Philadelphia and the Engineering Societies of New England. The Engineers Society of Western Pennsylvania, the Engineers Club of St. Louis, and the Michigan Engineering Society have voted to recommend to their executive committees that they join. Membership is under consideration by the Louisiana Engineering Society, the Illinois Engineering Society, and the Cleveland Engineering Society. Interest has been manifested by several others.

Following is a brief record of outside activities of the Executive Secretary:

January 31. Spoke, Engineers Club of St. Louis.
February 1. Spoke, 50th Annual Meeting, Illinois Society of Engineers, East St. Louis, Ill.
" 2. Met with Board of Direction, Engineers Club of Cincinnati.
" 4. Attended Annual Meeting, National Bureau of Economic Research, New York.
" 15. Attended National Conference of Business Paper Editors, Washington.
" 22. Spoke, Michigan Engineering Society and Associated Technical Societies of Detroit, in Detroit. Subject: "A New Survey of American Engineers and Its Significance."
" 25. Luncheon Meeting, Pittsburgh Section, Am. Soc. C.E.

February 26. Attended Annual Dinner, Engineers Society of Western Pennsylvania, Pittsburgh, Pa.

March 4. Conference, Secretaries of Founder Societies, New York, N.Y.

Copies of the minutes of the Secretaries Conference and of the Symposium of Federal Activities presented at the Annual Meeting are available on request. The Directory of Engineering Societies also is ready for distribution at 50 cents per copy. Secretaries of local societies and sections may extend their acquaintance with engineering groups in nearby states by use of this handbook. It includes the names of officers, membership requirements, names of publications, and other data regarding national, state, and local societies.

Washington, D.C.
March 8, 1935

Record of Engineering Societies Library in 1934

ONE of the important cooperative phases of Society work is the Engineering Societies Library, maintained in the Engineering Societies Building at Headquarters. This organization represents a joint effort to which all the Founder Societies contribute of their means and of their facilities, and in which all engineers, whether or not they belong to one of these societies, are welcome to participate. Many worth-while activities of the Engineering Societies Library are indicated in its Annual Report for the year 1934, from which the following excerpts are taken:

"It is gratifying in view of the scattered membership of the Founder Societies, to call attention to the use that distant members make of the library. Of those using it in 1934, twenty-six per cent were non-visitors, served by telephone or correspondence. This proportion of one in four is greater, it is believed, than in any comparable library. It shows that this is not a local institution, of benefit only to those in its immediate vicinity.

* * * * *

"It is a pleasure to report that it has been possible to maintain all important periodical files, to bind new accessions and do some rebinding, to catalog the material received, and to carry on all routine activities. The shortened hours adopted in 1933 have been continued during the year, however, and book purchases have been restricted, of necessity, to works that were essential.

* * * * *

"The library was used by 40,789 persons during 1934. Of these 29,928 were readers, and 10,861 were non-visitors who consulted the collection by correspondence. The corresponding figures for 1933 were 32,258 and 10,657. Sixty-eight searches and 109 translations were supplied, and 143 books were lent to 127 members. Photoprint orders from 2,366 persons required the making of 18,493 photographs. Assistance was given to 2,907 persons by letter and to 5,284 by telephone.

* * * * *

"Total acquisitions of books, maps, pamphlets, etc., amounted to 10,410 items, a small increase over 1933. Of these, 1,243 were purchased, the remainder being presented by members of the Founder Societies, publishers and other friends.

"Of these acquisitions, 6,576 were in our field and not already in the library. These were added. Fifty-five others were placed in the loan collection. The remainder were placed in the duplicate collection for disposal, as circumstances warranted, by exchange, sale, or gift.

"The largest gift was from the estate of the late J. Waldo Smith, Member of the American Society of Civil Engineers; this comprised 600 volumes and 1,000 pamphlets upon water-supply engineering.

* * * * *

"On January 1 the book collection comprised 131,793 volumes, 6,847 maps, 4,220 searches, and 800 pamphlets. The corresponding figures for December 31 were 134,344 volumes, 6,965 maps, 4,241 searches and 70 pamphlets.

"The loan collection on December 31 contained 782 volumes, and the duplicate collection approximately 11,000 volumes.

* * * * *

"During the year 2,821 volumes, representing 2 843 titles, were cataloged. Of the 145,620 volumes, maps, etc., on hand, 145,285 are fully cataloged, and the remainder are in process.

"The current index to periodicals has been increased by 17,037 titles, and now has entries for 117,085 articles. These are classified and indexed, and provide a readier guide to current articles than the published guides, which usually cover only one year per volume. Readers find it increasingly helpful, and as it grows it becomes more and more self-sufficient for most needs."

For the year 1934, the representatives of the Society on the Library Board were Othmar H. Ammann, James F. Sanborn, George T. Seabury, Charles E. Trout, and J. J. Yates, all Members Am. Soc. C.E.

Officers of Founder Societies in Joint Meeting on May 20

OFFICERS and directors of the Founder Societies of civil, mining and metallurgical, mechanical, and electrical engineers, and of their several jointly sponsored functional organizations will all meet together for dinner on Monday, May 20, 1935, at the Engineers' Club in New York, according to plans recently announced by the United Engineering Trustees, Inc., acting for the societies in sponsoring the meeting. This is the first time in the history of the engineering societies that any such meeting has been undertaken, and it is considered to be an important step toward the establishment of a clearer understanding of the scope and significance of the work carried on jointly by the several societies.

A wide variety of technical and other activities of importance to every branch of the engineering profession is now, and for many years has been, carried on by the agencies jointly created and sponsored by the Founder Societies: the United Engineering Trustees, Inc., and its two departments, the Engineering Societies Library and the Engineering Foundation; the American Standards Association; the Division of Engineering and Industrial Research of the National Research Council; the Engineering Societies' Employment Service and the Engineers' National Relief Fund; the American Engineering Council; and, more recently, the Engineers' Council for Professional Development. The activities, ideals, and procedures of each of these agencies will be described and explained concisely by society representatives long associated with the work in each case.

With a fuller understanding thus established among the personnel of the governing bodies of the several societies, it is hoped that more direct channels will be established through which the individual members of the societies may become better acquainted with the variety of professional services directly available to them. This, in turn, is important from at least two angles: first, in order that each member may know how to make use of these services, and second, that each member may realize the extent to which his own small contribution is magnified through effective cooperation.

Plans for this joint dinner meeting have grown out of discussions that began in January, between the United Engineering Trustees and the secretaries of the Founder Societies. The committee in charge includes Alfred D. Flinn, M. Am. Soc. C.E., director of the Engineering Foundation, chairman; H. V. Coes, president of the United Engineering Trustees, Inc., honorary chairman; George T. Seabury, Secretary of the American Society of Civil Engineers; A. B. Parsons, secretary of the American Institute of Mining and Metallurgical Engineers; C. E. Davies, secretary of the American Society of Mechanical Engineers; H. H. Henline, secretary of the American Institute of Electrical Engineers; and John Arms, secretary of the United Engineering Trustees, Inc.

SIXTY-FIFTH ANNUAL CONVENTION, July 3, 4, and 5, 1935, in Los Angeles, Calif.

Preview of Proceedings

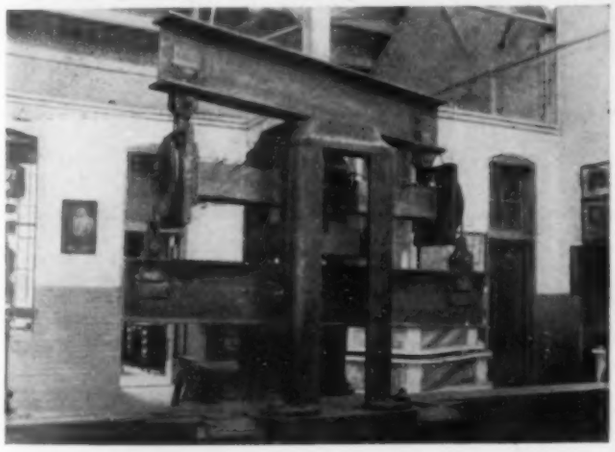
Subjects of particular interest to structural engineers, city engineers, and surveyors will be treated in the April issue of PROCEEDINGS, *the two main papers dealing with structural beams in torsion and the adjustment of level nets. The progress report of the Sanitary Engineering Division, omitted from the March issue because of lack of space, will also appear.*

STRUCTURAL BEAMS IN TORSION

THE APRIL issue of PROCEEDINGS will have a paper on "Structural Beams in Torsion" by Inge Lyse, M. Am. Soc. C.E., and Bruce Johnston, Jun. Am. Soc. C.E. This paper is a report on an investigation carried out by the Fritz Engineering Laboratory at Lehigh University in cooperation with the McClintic-Marshall Corporation.

Rolled structural steel shapes are designed to be efficient in resisting shears and moments in one prescribed plane. When such beams are loaded unsymmetrically, or subjected directly to torsional moments, high torsional stresses may be developed at relatively low loads. If these adverse conditions of loading cannot be avoided in structural design, it becomes necessary to study the torsional properties of such sections.

Structural beams in torsion are very limber. Light-weight sections of thin material will twist to a marked degree without exceeding the elastic limit of the steel. Hence twisting or rotational deflections of a beam may assume even greater importance than the torsional stresses involved. The forthcoming paper gives accurate formulas for computing the torsional constant or twisting modulus of structural beam sections. The accurate evaluation of these formulas was made possible through the application of Prandtl's soap film analogy.



TORSION-TESTING EQUIPMENT, LEHIGH UNIVERSITY

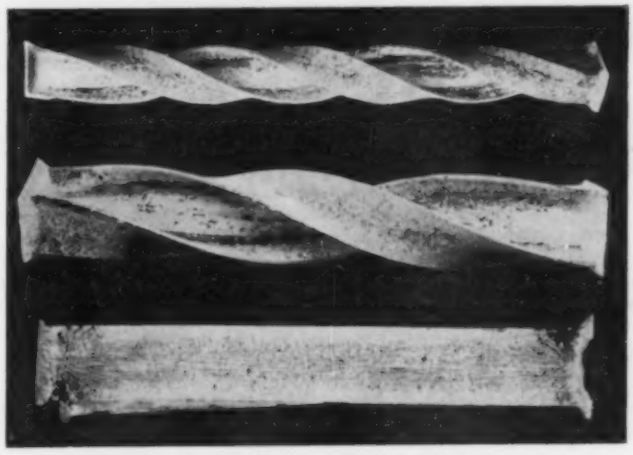
Structural steel beams may be torsionally strengthened and stiffened by boxing in and fixing their ends. This subject is also treated in the paper, and there is a report on the experimental work, giving the details of fixed-end torsion tests on 22 steel beams of varying length and size, and free-end tests on 7 sections. The beams tested ranged in size and shape from a 3-in. I-beam at 7.5 lb per ft to a 12 by 12-in. H-section weighing 190 lb per ft.

The results of these tests provided a physical check on the formulas for the torsion constant as determined by soap film tests. During the tests the stresses were also measured with the aid of Huggenberger tensometers. Proposed formulas for critical torsional shearing stress are given. The question of combined bending and torsion is not considered, but the results of the investigation are directly applicable to such problems.

The paper includes a brief bibliography on the subject of torsion, and two discussions will be published as a corollary to it. These discussions are available in advance due to the fact that they represent joint studies made by their authors in connection with the present investigation. The first, by H. M. Westergaard, M. Am. Soc. C.E., and R. D. Mindlin, Jun. Am. Soc. C.E., takes up the subject of torsional stress concentrations in fillets. The second, by Prof. J. B. Reynolds, of Lehigh University, deals with special problems arising from fixed-end conditions and the linear variation of torsional moments.

THE ADJUSTMENT OF A LEVEL NET

AN IMPORTANT paper of interest to city engineers and surveyors will appear in the April issue of PROCEEDINGS under the title of "The Adjustment of a Level Net" by George H. Dell, Assoc. M. Am. Soc. C.E. Two closely related methods of obtaining a least-squares adjustment of the closing errors in a level net are described in this paper. In the first method, the appropriate normal equations and their subsequent solutions are written by a process of converging increments. In the second method, the principle of successive distribution is utilized as suggested by the Cross method of moment distribution. Both methods are well adapted to the use of the slide rule and possess the advantages of simplicity and brevity as compared with the conventional least-squares solution.



EXAMPLES OF SPECIMENS TESTED IN TORSION

According to the author, they are intended to apply primarily to surveys of ordinary extent and accuracy, such as those executed by municipal and highway engineering organizations.

Although fundamentally the paper deals with the basic theory of condition equations, it contains a considerable number of new features. These include (1) a method of solving the normal equations; (2) the application of the distribution principle to the adjustment of errors introduced by Hardy Cross, M. Am. Soc. C.E.; (3) the introduction of an improved system of direction arrows; (4) the presentation of rules for writing the normal equations by inspection; and (5) a simplified treatment of the subject of least squares and the theory of errors.

Appointment of Society Representatives

JOHN F. COLEMAN, Past-President Am. Soc. C.E., has accepted an appointment as Society representative on the John Fritz Medal Board of Award to fill the vacancy caused by the death of Francis Lee Stuart, Past-President Am. Soc. C.E.

ARTHUR S. TUTTLE, President Am. Soc. C.E.; HERBERT S. CROCKER, HARRISON P. EDDY, and ALONZO J. HAMMOND, Past-Presidents Am. Soc. C.E.; and GEORGE T. SEABURY, Secretary Am. Soc. C.E., have been appointed to represent the Society on the American Engineering Council.

B. A. SMITH, M. Am. Soc. C.E., represented the Society at the Engineering Conference of the Institution of Engineers of Australia, held in Melbourne, Australia, March 4–9, 1935.

A. J. HAMMOND, Past-President Am. Soc. C.E., served as Society representative at a dinner meeting held in Chicago, Ill., on February 20, 1935, in honor of the presentation of the Washington Award to Ambrose Swasey, Hon. M. Am. Soc. C.E.

L. G. HOLLERAN, M. Am. Soc. C.E., has been appointed alternate Society representative on the Council of the American Standards Association.

No More Reprints of Cross Sections of Dams

IN CONNECTION with the paper, "Security from Under-Seepage—Masonry Dams on Earth Foundation," by E. W. Lane, M. Am. Soc. C.E., in the September 1934 issue of PROCEEDINGS, a pamphlet containing numerous cross sections of constructed dams was reprinted by the Society. A number of notices to this effect were given in order that members might avail themselves of the possibility of obtaining these valuable details.

That advantage was taken of this opportunity is evidenced by the fact that the Society's supply of the reprints has recently been exhausted. This is especially significant in view of the extra large number originally printed in order that the supply might be ample and the cost moderate.

While this situation is very gratifying, especially because most reprints furnished by the Society involve a financial loss, nevertheless it is disappointing not to be able to fill further requests for these cross sections. Those members who avoided this disappointment by ordering promptly will place a correspondingly higher value on this set of diagrams, together with the bibliography and index attached.

Society Membership Fraudulently Claimed

IT FREQUENTLY happens that members of the Society are approached by individuals claiming to be fellow members and asking for financial assistance on that ground. Often it is difficult for the member approached to verify the accuracy of the statements made to him. In any case of reasonable doubt, when local inquiry fails to yield the desired information, a letter addressed to Society Headquarters will have prompt consideration. The staff is in a position to aid in investigating the accuracy of all such statements and the worthiness of such claimants. This procedure will save misapplication of funds and tend to discourage this practice of securing money under false pretenses.

Student Guidance Through Engineers' Council for Professional Development

IN FURTHERANCE of its charter objective "to enhance the professional status of the engineer through educational activities," the Engineers' Council for Professional Development (E.C.P.D.) is now placing in operation another important part of its program. Recognizing that the first essential in improving the status of the engineering profession is improvement in the quality of the men entering it, the E.C.P.D., through its Committee on Student Selection and Guidance, has set up a program providing opportunity for those boys in secondary schools who may be interested in engineering to make direct contact with individual members of the several participating professional societies who can give them sympathetic advice in choosing their career.

It will be recalled that the E.C.P.D. is an agency created and jointly sponsored by the Society and six other national bodies. Organized on October 3, 1932, it functions through four standing committees: those on Student Selection and Guidance, Engineering Schools, Professional Training, and Professional Recognition. The intended field of service of each of these committees corresponds to one of the four major periods in the development of an engineer: first, the selection of a career; following this, the acquisition of technical training of recognized merit; then, after graduation, the period of first practical experience as a junior engineer; and finally, certification as a qualified engineer.

The personnel of the Committee on Student Selection and Guidance is as follows: R. L. Sackett, M. Am. Soc. C.E., dean of the College of Engineering, Pennsylvania State College, State College, Pa., chairman; O. J. Ferguson, dean of the College of Engineering, University of Nebraska, Lincoln, Nebr.; W. B. Plank, Professor of Mining Engineering, Lafayette College, Easton, Pa.; H. N. Davis, president of Stevens Institute of Technology, Hoboken, N.J.; T. Keith Legaré, M. Am. Soc. C.E., secretary, National Council of State Boards of Engineering Examiners, Columbia, S.C.; R. H. Jacobs, M. Am. Soc. C.E., Englewood, N.J.; and V. M. Palmer, industrial economy engineer, Eastman Kodak Company, Rochester, N.Y.

Through the instrumentality of this committee, officers of the local units of the participating societies throughout the United States have been called upon to form in each locality "a sympathetic, understanding committee, which will actively promote guidance through contact and advice with the students, high school principals, vocational counselors, and others." Engineering schools also are being asked to cooperate. The detailed program of each local committee of course will depend upon conditions in its vicinity, but all will be guided by the common objective—a better understanding of the educational requirements of, and vocational opportunities for, engineers "in order that only those may seek entrance to the profession who have the high quality, aptitude, and capacity which are required of its members."

To meet the need for information written in terms and forms understandable and appealing to the immature and inexperienced student, to his high school teacher, and to his parents, the E.C.P.D. Committee on Student Selection and Guidance after a wide canvass has selected the booklet, *Engineering, a Career—a Culture*, as the most satisfactory text. This attractive 64-page pamphlet was prepared by the Educational Research Committee of the Engineering Foundation late in 1932, and already over 50,000 copies have been distributed to engineers, teachers, and others interested in the subject. It is descriptive of the profession of engineering—its spheres of action, the training and the qualities required for its successful pursuit, the obligations which it imposes, and the rewards which it affords. Also, the practical usefulness of an engineering education in vocations other than engineering is illustrated by the experience of many men in divers callings. Copies of this pamphlet are still available and may be obtained from the Secretary of the Engineers' Council for Professional Development, 29 West 39th Street, New York, N.Y. The price is 15 cents a copy, or 10 cents in lots of 50.

Regular March Society Meeting

THE REGULAR Society Meeting for March, as required by the By-Laws, was called to order by President Tuttle on the evening of March 20, 1935, just preceding the meeting of the Metropolitan Section at the Engineering Societies Building. After remarks by the President, there being no business presented, the meeting was adjourned.

News of Local Sections

ALABAMA SECTION

The following officers were elected by the Alabama Section for the year 1935: W. H. Caruthers, president; A. C. Decker, first vice-president; R. D. Jordan, second vice-president; and H. A. Davies, secretary-treasurer.

CENTRAL OHIO SECTION

There were 51 members and guests present at a meeting of the Central Ohio Section held on January 24. The speaker of the evening, Henry W. Worley, gave an interesting talk on the relations of engineers to civic development.

CINCINNATI SECTION

A meeting of the Cincinnati Section was held on February 4 at the Engineers Club. At this session Capt. A. C. Lieber, an executive officer in the U. S. Army, spoke on the engineering and economic aspects of the Muskingum Project. His address proved to be of great interest to the 125 members and guests who were present. The following officers have been elected for 1935: C. M. Stegner, president; Pusey Jones, vice-president; and Wm. W. Carlton, secretary-treasurer.

CLEVELAND SECTION

The Cleveland Section held a meeting on February 5 at the Chamber of Commerce Club. The 38 members and guests present heard Peter Witt speak on "A Comprehensive Plan for Downtown Cleveland Traffic." The discussion following the address was lively and instructive.

DAYTON SECTION

At a meeting of the Dayton Section held on January 21 at the Engineers Club, E. O. Keator exhibited several of his inventions and explained the difficulty of marketing them. There were 15 members in attendance. On February 18, the Section was addressed by Paul Koller, Professor of Astronomy, Mineralogy, and Geology at the University of Dayton, who spoke on "Geology of the Miami Valley." In addition to the 16 members present, 5 students from the University of Dayton attended.

INDIANA SECTION

On February 19, the Indiana Section held a meeting at Indianapolis, which was attended by more than 150 engineers. Interesting talks were given by Frank R. Innes, Western Editor of the *Electric World*, who spoke on "The Federal Hydro-Electric Program," and S. C. Hollister, director of the School of Civil Engineering of Cornell University, who addressed the audience on "Analysis of Structural Defects by Use of Polarized Light." The following officers were elected by the Section: John W. Wheeler, president; R. L. McCormick, vice-president; and Fred Kellam, secretary-treasurer.

IOWA SECTION

At a meeting of the Iowa Section held in Des Moines on February 6, S. J. Jackson, of the U. S. Geological Survey at Iowa City, spoke on "A Review of the Report of the Mississippi Valley Committee." There were 70 members and guests in attendance.

KANSAS STATE SECTION

At a meeting of the Kansas State Section, held on February 13 at Topeka, the following officers were elected: A. B. Griggs, president, and F. A. Russell, vice-president.

LOS ANGELES SECTION

The regular monthly meeting of the Los Angeles Section, which was held at the University Club on March 13, constituted one of the sessions of a two-day conference on water conservation. The speakers of the evening were: Harry E. Reddick, Regional Director, U. S. Soil Erosion Service, Santa Paula; Lewis A. Jones, chief of the Division of Drainage and Soil Erosion, Washington, D.C.; Paul Baumann, Assistant Chief Engineer, Los Angeles County Flood Control District; J. B. Lippincott, consulting engineer, Los Angeles; and E. W. Kramer, Regional Engineer, U. S. Forest Service, San Francisco. Control of erosion was the subject of these talks, in which particular reference was made to check dams and debris dams as a method of control.

METROPOLITAN SECTION

The March meeting of the Metropolitan Section, which was held in the Engineering Societies Building in New York, N.Y., on March 20, 1935, was devoted to consideration of the subject, "An Inventory and a Plan for Development of the Water Resources of the United States," referring to the comprehensive work of the Water Resource Section of the National Resource Board. This board recently concluded an intensive study and published its results in an elaborate report. The speaker of the occasion was Thorndike Saville, M. Am. Soc. C.E., former executive engineer of the board, who described the purposes and details of the work, illustrating the summary of the findings by a large number of maps and charts. Following his interesting talk, a number of discussions were given from the floor. At the conclusion of the meeting refreshments were served. The attendance was about 300.

MILWAUKEE SECTION

At the regular meeting of the Milwaukee Section, held on January 31, and at a special meeting, held on February 18, the proposed amendment to the Engineer's Registration Law was discussed at length. The subject elicited much interest and enthusiasm.

NORTHWESTERN SECTION

On February 28 the Northwestern Section held a meeting at the University of Minnesota that was attended by 45 members and guests. The session was addressed by George E. Loughland, hydraulic engineer of the Northern States Power Company, who spoke on "Operation of Hydro-Electric Property."

OKLAHOMA SECTION

The Oklahoma Section held a special meeting on January 24, at which the subjects of sewage disposal and the engineers' license law were discussed. The regular meeting, held on February 2 at Oklahoma Agricultural and Mechanical College, included an afternoon excursion to view terracing and soil erosion experiments. In the evening a supper meeting was held. The officers elected by the Section for 1935 are as follows: R. V. Lindsey, president; Donald Witten, vice-president; H. T. Lawrence, second vice-president; and Frank Herrmann, secretary-treasurer.

PHILADELPHIA SECTION

At a meeting of the Philadelphia Section, held on January 16 at the Engineers Club, a variety of subjects was discussed. The speakers included R. C. Sutton, chief administrative assistant of the Philadelphia engineer district, who spoke on the employment of engineers and administrative personnel; W. N. Thomas, Jr., who discussed the Fort Peck Project; L. D. Shuman, who outlined engineering projects in the Philadelphia area; and Howard Ker, who discussed the Chesapeake and Delaware Canal Project. The meeting was opened and closed by John C. H. Lee, Corps of Engineers, U. S. Army, who emphasized the necessity of cooperation between civil and military engineers.

SAN FRANCISCO SECTION

A joint meeting of the San Francisco Section and local branches of the American Institute of Electrical Engineers, the American Society of Mechanical Engineers, and the Structural Engineers Association was held on February 19 at the Engineers Club. Dinner was followed by a technical meeting, at which Stephen Timoshenko spoke on "Recent Developments in Fatigue Tests of Structural and Machine Parts." There were 350 members and guests in attendance at the meeting.

UTAH SECTION

On January 18, the Utah Section elected the following officers for 1935: F. M. Allen, president, and F. H. Richardson, secretary. There were 28 members present at the session at which elections were held.

Student Chapter News

LEWIS INSTITUTE

The Lewis Institute Student Chapter held a smoker on January 25 at the Engineers Club in Chicago. In addition to speeches by students, Fred A. Rogers, Dean of the Engineering Department of Lewis Institute, spoke on the possibilities of expanding the department, and J. G. Bennett, Professor of Civil Engineering, gave a short talk on the importance of becoming acquainted with fellow engineers.

OREGON STATE AGRICULTURAL COLLEGE

The members of the Oregon State Agricultural College Student Chapter made an inspection tour on December 28 to the Bonneville power project. The party made a close inspection of the work at Bradford Island and after lunch saw a demonstration of the

MEMBERS OF OREGON STATE AGRICULTURAL COLLEGE STUDENT CHAPTER INSPECT BONNEVILLE DAM

large-sized model of the river bed and dam at Linnton, Oregon. On January 27 the Chapter held a breakfast meeting at which W. R. B. Willcox, of the Department of Architecture at the University of Oregon, spoke on the scientific truths in economic laws.

ITEMS OF INTEREST

Engineering Events in Brief

CIVIL ENGINEERING for May

IN ATTEMPTING to give unusually generous treatment to the papers presented at the Annual Meeting of the Society in January 1935, it has been found necessary to use two issues of CIVIL ENGINEERING rather than a single one. In the meantime, a number of fine papers have accumulated and are available for the May number.

Two articles on highways will be found timely. In one Bruce D. Greenshields, Assoc. M. Am. Soc. C.E., describes a new method of traffic study that utilizes motion picture cameras giving 88 exposures per minute—in reality a visual traffic count. By including in the photographs a bulletin board showing fixed data and a clock giving the exact time, a complete and permanent record is obtained. In particular, the results are interesting as they throw light on the relationship between speed, spacing of vehicles, and density of traffic. The other article describes the results of an investigation to determine the cost of passenger automobile stops. In it T. T. Wilson, Jun. Am. Soc. C.E., gives a clear explanation of the set-up for the tests, measurements of speed, and gasoline consumption. He also presents graphs showing the bearing of velocity on the gasoline used for stops. Finally he computes the total cost, including tires, oil, and maintenance. A variety of cars and speeds were studied.

Under the title, "Modern Engineering Colleges," N. W. Dougherty, M. Am. Soc. C.E., cites some of the developments that have added importance to advanced technical training. He develops the thesis that a grave responsibility devolves upon the college of today, which must take the lead, with better teaching, more research, and greater inspiration for its students.

One of the articles planned for the January number but deferred to the May issue at the last moment because of lack of space, describes a novel method of model testing as used at Columbia University. The authors of this article are Messrs. Philip B. Bucky, Arshag G. Solakian, and L. S. Baldin. The distinctive features of this method involve, first, the loading of the model by centrifugal apparatus, and then the photo-elastic measurement of the revolving transparent model. Much higher relative loads are thus imposed on the material, increasing the range of the tests and the size of the models.

A number of other valuable papers are also in prospect. Special mention may be made of one dealing with the Boulder Dam project, by Walker R. Young, M. Am. Soc. C.E., and of another on the treatment of contraction joints for the Hogan Dam on the Calaveras River in California.

Student Design Competition

PRIZES FOR excellence in bridge design are announced for the seventh successive year by the American Institute of Steel Construction. These will consist of cash prizes to students of engineering and of architecture for the most beautiful design of a steel grade-crossing elimination bridge.

Students registered at some 200 technical schools and colleges teaching architecture or structural engineering have been invited to participate. Ten of the best designs will be selected for final judgment, which is to be made on May 1. The jury to make the selections will consist of Shortridge Hardesty, M. Am. Soc. C.E., of the engineering firm of Waddell and Hardesty; E. R. Needles, M. Am. Soc. C.E., of the engineering firm of Ash-Howard-Needles and Tammen; J. Andre Fouilhoux, M. Am. Soc. C.E., of the architectural firm of Hood, Godley and Fouilhoux; H. Craig Severance, architect; and A. Lawrence Kocher, managing editor of *The Architectural Record*.

That student design judged the best will receive a cash prize of $100, and the second best a cash prize of $50. Certificates will be awarded those receiving honorable mention.

The design competition has been so drafted as to stimulate student interest in designing grade-crossing eliminations, a type of work which is most prominent at the present time. According to the works program proposed by the Federal Government, contracts may be let for the removal of some 5,000 grade crossings most dangerous to highway travel. This will require a public appropriation of approximately half a billion dollars. The elimination of these dangerous crossings not only will prove a benefit to motorists but at the same time should be seized upon as an opportunity for enhancing the beauty of the highways. Here is a problem which, it is believed, will especially appeal to students of engineering and architecture.

In this competition the design is to be for a three-lane steel bridge carrying a highway over a railroad and another highway parallel to the railroad. There are to be connections for two lanes of traffic between the upper and lower highways, and no crossing of lines of traffic must occur when entering or leaving the bridge. The surrounding country is flat, and the maximum grades on the approaches and highway connections are not to exceed 5 per cent. As the structure is for the open country, there need be no provision for sidewalks or for lighting.

New Work on Alloys of Iron

ONE of the many interesting activities under the Engineering Foundation is the Alloys of Iron Research. The extensive studies which have been going on over a period of years have resulted in the publication of four noteworthy volumes covering alloys of iron—with copper, tungsten, molybdenum, and silicon. These four extensive volumes are doubtless familiar to most engineers dealing actively with iron alloys.

Now comes a special monograph entitled "Principles of Phase Diagrams," by J. S. Marsh, physical metallurgist and associate editor of the Alloys of Iron Research. Although such diagrams have wide usage in metallurgy, their practical interpretations have been too little understood.

Accordingly, Mr. Marsh has addressed himself to the problem of the better understanding of phase diagrams. In this way it becomes unnecessary to devote any space in the regular monograph series to this important question. This volume has 193 pages and 180 illustrations. If ordered immediately, the introductory price is $2.25 per copy; thereafter the regular price will be $3.00. The publisher is the McGraw-Hill Book Company, Inc., 330 West 42d Street, New York, N.Y.

The Panama Canal: A Memorial to a Great American

ON THIS month's Page of Special Interest are reproduced two of the mural paintings in the New York State Roosevelt Memorial Building adjoining the Museum of Natural History in New York, N.Y. Their theme is the building of the Panama Canal, in which Theodore Roosevelt took an active part. The designs for the murals were chosen after a competition in which 25 artists submitted sketches. The artist is William A. Mackay of New York, who during the World War used his talent

SIXTY-FIFTH ANNUAL CONVENTION, July 3, 4, and 5, 1935, in Los Angeles, Calif.

in the Navy, in camouflaging transports.

The murals are 34 ft high. The panel at the left pictures the early history of Panama and the Mayan and Aztec origins of its people. In the central group, five Spanish señoritas hold products of the west coast of South America. Below them Neptune is shown handing to the Pacific Ocean, personified, the tugboat *Gatun*, the first craft to pass through the Canal.

At the top of the right panel stands Balboa, the discoverer of the Pacific Ocean, and a native Mayan in ceremonial headdress. Below, the gentleman pirate leader, Sir Henry Morgan, holds a ship model. The rest of this panel is devoted to the chief figures in the construction of the Canal. A French army officer with plans in his hand stands beside the ruins of an abandoned and jungle-covered excavator, facing Count Ferdinand de Lesseps, and the figure of a woman, typifying France. Theodore Roosevelt is discussing plans with John F. Stevens, Honorary Member and Past-President of the Society, and chief engineer of the project. On the right, under the flag of the Army Medical Corps, stands Col. W. C. Gorgas, who drove the yellow fever mosquito from the Canal Zone and made construction possible. A negro is spraying the mosquito-infested water while a native attendant holds up a jug of water for examination. On the left, bearing the ensign of the Corps of Engineers, is Col. George W. Goethals, who also was a member of the Society. Below the model of the Gatun Locks stand figures representing Columbia and Liberty.

Of course the rich colors of the original painting are not here reproducible. Indebtedness for this excellent photographic reproduction is acknowledged to Peter Juley, New York.

A.S.M.E. Publishes New Quarterly

THE FIRST issue of a quarterly periodical has recently been published by the American Society of Mechanical Engineers. The aim of this new publication, which has been named *Journal of Applied Mechanics*, is to meet the need for a technical journal that will present progress in the fields of general mechanics, elasticity, hydrodynamics, aerodynamics, strength of materials, and thermodynamics in a form readily applicable to engineering practice.

In addition to contributions dealing with developments, achievements, and researches, as described in papers presented at meetings of the Applied Mechanics Division of the American Society of Mechanical Engineers, the journal will contain reviews of important books and foreign articles. There will also be other information of interest and value to readers. The annual subscription rate—for those not already receiving this journal through membership in the American Society of Mechanical Engineers—is $5, and subscriptions should be forwarded to that society, at 29 West 39th Street, New York, N.Y.

Survey of Engineering in 1934

ENGINEERING progress vitally affects all sorts and conditions of men. A good example is found in the practice of the National Geographic Society in issuing one of its regular *Geographic News Bulletins* covering engineering advances over a period of a year, particularly to emphasize the effect of important construction projects on the physical and economic geography of the world. Through the courtesy of that society, we are privileged to quote herewith a terse account of some of the major engineering milestones.

According to the current *Geographic News Bulletin*, the year 1934 saw the completion of the 1,200-mile oil pipe line in Iraq, Palestine, and Syria; first use of the world's largest under-water traffic tunnel beneath the Mersey; the shaping up of the first transcontinental railway route through the backbone of the Rocky Mountains, west of Denver; the inauguration of travel by streamline, Diesel-engine-driven railway trains; the completion of San Francisco's gigantic water-supply system from the Hetch Hetchy Valley; the end of construction on the first bridge to cross the lower Zambezi River in Africa; and the throwing open for use of an 11½-mile railway tunnel through the Apennines, in central Italy—the longest double-track railway tunnel yet constructed. The most unusual engineering project of the year probably was the starting of work to air-condition and cool the world's deepest gold mine, a maze of shafts and passages near Johannesburg, South Africa, which reaches to a depth of 8,380 ft.

From the ways near Glasgow, Scotland, on September 26, came the hull of a $30,000,000 giant passenger ship, christened *The Queen Mary*. The hull was 1,018 ft long and it was estimated that its tonnage would pass 75,000. At the same time, at St. Nazaire, France, another huge ship, *The Normandie*, which will have a tonnage of more than 79,000, was nearing completion.

IMPORTANT U. S. RAIL LINK

The railway pattern of the world continued to undergo the changes that have been shown during the past few years. In the United States, more trackage was abandoned than the new trackage constructed; the outstanding addition was the Dotsero Cut-Off, a 38-mile length of track between Oresto and Dotsero in western Colorado. It put into use for the first time for a transcontinental route, Moffat Tunnel through the Continental Divide west of Denver, saving 175 miles between Denver and Salt Lake City.

Notable extensions of railway mileage took place in countries in a pioneering stage, or in which engineering development has lagged in recent decades. Three of the most important railway projects completed were in Africa. In French Equatorial Africa a 318-mile railway was opened, connecting the 6,000 miles of navigable waters of the Congo River with the sea at Pointe Noire. In eastern Africa rails were extended northward for 162 miles in Nyasaland Protectorate (British) almost to Lake Nyasa, and connecting in the south with tracks that lead over the new Zambezi Bridge. In French Morocco 75 miles of rails, built during 1934, from Fez to Taza, completed the 1,700-mile railway system extending from Tunis to the Atlantic coast of Morocco.

CONTINUED CONSTRUCTION IN MANCHURIA

Other important railway building of the year included:

A 140-mile stretch in Manchuria (Manchutikuo) from Lafa to Harbin, furnishing a more direct route from Seishin, new Japanese port of northern Korea, to Harbin and the region northward toward the Amur River; 78 miles of track between Koupeiyingtzu and Lingyuan, Manchuria; an electric line 53 km long in the Ural district of the Soviet Union, connecting Chusava and Baska; in Finland, a 57-km length of track on the north shore of Lake Laatokka (Ladoga); 50 km added to the Persian railway that will extend from the Persian Gulf to Tehran and beyond to the Caspian Sea; 31 miles of track in Latvia, from Dundaga to Ventspils; Polish trackage, 60 miles long, connecting Warsaw and Radom; in Turkey, 70 km between Elaziz and Malatya, about 200 miles south of Trebizond, in Asia Minor; Brazilian extensions, mostly in Sao Paulo and Rio Grande do Sul; and in the United States, electrification of trackage of the Pennsylvania Railroad south of Wilmington, Delaware, in the project that will connect New York City and Washington by an all-electrified system.

THE IRRAWADDY'S FIRST BRIDGE

One of the notable bridges completed during the year was the first structure to cross the Irrawaddy River in Burma. It is near Mandalay. Work was carried on during the year on the two bridges at San Francisco, across the Bay and across Golden Gate—two of the greatest bridge construction jobs ever undertaken. The largest lift-bridge ever constructed was put into use at Middlesbrough, England, across the River Tees. The movable deck is 270 ft long and lifts 100 ft above the water.

The largest dam finished during the year was the Mattur irrigation dam in the Cauvery River, Madras Province, India. More than a mile long, and 176 ft high, it will impound 660,000,000 gal of water. Recoleta irrigation dam, completed in Chile, not far from Santiago, is the largest in South America. The greatest of Spanish dams was completed in the Duero River near Zamora. It was built primarily for power generation. In West Virginia, the Marmet Dam in the Kanawha River, near Charleston, extends Mississippi-Ohio navigation more than 100 miles into a country of rich coal fields.

AMERICAN HYDRO-ELECTRIC PROJECTS

Tremendous Boulder Dam, in the Colorado River near Las Vegas, Nev.,

has steadily grown during the year as millions of tons of concrete have been dumped into its forms. Southwestward from the dam the vast pipe-line project that will carry Colorado River water to Los Angeles, has steadily advanced. It is entailing the boring of numerous tunnels. Three large hydro-electric and irrigation projects in the West were gotten under way during the year: at Grand Coulee, Washington and at Bonneville, Oregon, both on the Columbia River; and at Fort Peck, on the Missouri River, Montana. In the Tennessee Valley the Norris Dam is rising in the Clinch River near Knoxville, and the Wheeler Dam is taking shape in the Tennessee River above the Wilson Dam.

Highways were extended, broadened, and modernized in hundreds of sections of the United States and in many foreign countries. Outstanding among completions of new highways was that of the New Highlands Road in Scotland, from Glasgow to Inverness. Near the close of the year, Hawaii formally dedicated a new highway on the Island of Maui leading from sea level to the rim of the huge crater of Haleakala, 10,000 ft above sea level, and 20 miles in circumference. Work continued on the first highway from the Texas border to Mexico City. It was estimated late in the year that grading will be completed on the last link of 60 km in March 1935.

Second in importance only to England's Mersey Tunnel, was the East Boston Traffic Tunnel, running under a part of the harbor from Boston to East Boston. It was opened June 30. Work was started in May on New York City's newest traffic tunnel, the mid-town Hudson tube to connect Manhattan and Weehawken, N.J. Two of the world's great cities figured in subway work during the year. A new underground system, the third, was completed and inaugurated in Buenos Aires in November. It is 5 miles long. The first trial train was operated in the Moscow subway over a 2-mile section, October 15. The 8-mile system will be completed in 1935.

In Germany, at Niederfinow, near Berlin, the world's largest canal-boat elevator was inaugurated, March 21. It connects two canals with a difference of 116 ft in levels. Completion of the new "hand-made" city of Sabaudia, Italy, was celebrated April 15. It is the second planned city to rise in the drained Pontine Marshes. New port works at Callao, chief port of Peru, were put into service October 24, 1934. Work was started by the Soviet Government on an unnamed port city at the mouth of the Lena River.

Any civil engineer, in reading these outstanding engineering projects as enumerated by the National Geographic Society, will feel deep pride in his profession. He is bound to note that he and his associates have held the key positions in these magnificent accomplishments.

Funds for the Engineering Index

IN BEGINNING its task of raising a working capital fund of $161,000, the Engineering Index, Inc., has been greatly stimulated by the acceptance on the part of Frank B. Jewett, president of the Bell Telephone Laboratories, Inc., of the position of national chairman of the campaign. It will be recalled that the former Engineering Index was discontinued as an activity of the American Society of Mechanical Engineers a year ago and is now being placed on an independent basis so that it may become self-sustaining.

In taking over his duties as chairman of the Engineering Index's National Committee, Dr. Jewett stated:

"The keeping of the records of science is one of the most important and valuable activities. Today the Index is the only agency which makes available to the engineer and research worker an exhaustive and continuing record of findings and developments in the technical field.

"In view of the enormous, unwieldy mass of current engineering literature, the absence of such a service would have serious and far-reaching consequences. Certainly if duplication of effort and the resulting economic loss is to be minimized, it is essential for the research worker at all times to be in a position to profit by what others have done and are doing.

"During the past year the continuance of Engineering Index as a non-profit corporation has been the concern of a small group of educators and engineers. The majority utilizing its service have taken such continuance for granted. It is my belief that if representative members of the profession and of industry are apprised of the actual situation, they will cooperate in providing funds needed to insure its permanence and make possible a program to widen its use.

"Soundly established, with adequate facilities for the exhaustive and systematic annotating and reporting of the findings in both pure and applied science, it will be insurance of continued and orderly progress, and as such, a national asset. Its support by industry is a matter of enlightened self-interest."

Great encouragement is found in the active support being given by a number of prominent engineers in all branches of the work of the Engineering Index. The campaign is being pushed actively with headquarters at 25 West 43d Street, New York, N.Y.

Blasting with Safety

WHAT is said to be an innovation in methods of blasting to ensure the maximum degree of safety was carried out at the quarry of the Giant Portland Cement Company at Egypt, Pa., on March 6, 1935. The blasting agent itself consisted of Nitramon, one of a newer type that can be handled with comparative safety and can be detonated only by some extreme explosive agent, in this case TNT. Attached to the TNT was 300 ft of cordeau, on the far end of which a blasting cap was placed. Thus the one product of a quick explosive nature, the cap, was removed a safe distance from the main explosive. In such an operation if anything had gone wrong, it would have been possible simply to remove the TNT and to dig out the Nitramon in perfect safety.

Explosion experts believe that this method is as injury-proof as any arrangement could possibly be. If its future is as favorable as this first test indicates, engineers and others may come to hail the experiment of March 6, 1935, as marking an epoch in attaining safety with high explosives.

NEWS OF ENGINEERS

From Correspondence and Society Files

KENNETH T. ATWELL is now employed by the University of California at Berkeley, Calif., as an assistant laboratory technician in the concrete research laboratory.

ELWIN H. QUINNEY has accepted a position as assistant state engineer inspector under the Federal Emergency Administration of Public Works for the states of Nebraska and South Dakota. His headquarters are at Omaha, Nebr.

EDMOND L. BELLADONNA, formerly with the U. S. Bureau of Public Roads, has accepted a position with the State Park Division, National Park Service, Department of the Interior, on Watoga State Park. He is now at Camp Seebert, Seebert, W.Va.

H. G. GERDES has been transferred from the U. S. Engineer Office in Portland, Ore., to the permanent staff of the Federal Power Commission, in Washington, D.C.

E. W. WENDELL has been promoted from the position of principal grade-separation engineer in the New York State Department of Public Works to that of assistant chief engineer in the same department. His offices are still in Albany, N.Y.

GEORGE E. HYDE is now employed in the Hydrographic Office of the International Boundary Commission, with headquarters in San Benito, Tex.

H. O. SCHERMERHORN has been appointed Commissioner of Canals and Waterways of the New York State Department of Public Works. He was formerly assistant chief engineer of the same department.

STUART K. KNOX has retired from partnership with Nicholas S. Hill, Jr., consulting engineer, to establish a private practice in hydraulic and sanitary engineering at 25 Warfield Street, Montclair, N.J.

CHARLES H. BUCKIUS is now a representative of the Penn-Dixie Cement Corporation, of Philadelphia, Pa.

Changes in Membership Grades

Additions, Transfers, Reinstatements, Deaths, and Resignations

From February 10 to March 9, 1935, Inclusive

Additions to Membership

Besson, Frank Schaffer, Jr. (Jun. '35), Holman 304, Mass. Inst. Tech., Cambridge, Mass.

Bowman, Frederic Berkeley (Jun. '34), Junior Engr., Design Dept., U. S. Bureau of Reclamation, Denver (Res., 2561 Sheridan Boulevard, Edgewater), Colo.

Brown, Andrew Roy (Assoc. M. '35), Chf. Engr. and Gen. Supt., J. W. Gwin and J. W. Gwin Co., Inc., 1801 Comer Bldg. (Res., 2219 Arlington Ave., South), Birmingham, Ala.

Buck, Roy McGarvey (Assoc. M. '34), Superv. Engr., Idaho State Geodetic Survey, Box 555, Boise, Idaho.

Campbell, William Alden (Jun. '34), 252 East Cedar St., Coalinga, Calif.

Carlson, Frank Bowers (Jun. '35), Junior Engr., U. S. Biological Survey, Box 1314, Minot, N.Dak.

Chambers, Robert Hamilton (Jun. '34), Draftsman, New York and Queens Gas Co. (Res., 133-14 Sanford Ave.), Flushing, N.Y.

Clark, Ben Hardin (Jun. '34), 316 North Carlisle, Albuquerque, N.Mex.

Clinton, Frank Mark (Jun. '34), Care, U. S. Geological Survey, Box 1311, Tucson, Ariz.

Conley, Hugh Gordon (Jun. '34), Junior Engr., Wilmington Refinery, Shell Oil Co., Wilmington (Res., 939 West 66th St., Los Angeles), Calif.

Doria Paz, Juan Crisostomo (Jun. '35), Designer and Draftsman, Compañia Fundidora de Fierro y Acero de Monterrey S. A., Bolivar 194, Monterrey, N. L., Mexico.

Flattery, Timothy Bernard (Jun. '34), E. C. W. Camp 58 P. E., Havana, Ill.

Goldsmith, Philip (Jun. '34), 589 Flatbush Ave., Brooklyn, N.Y.

Gollon, Frank Roseben (Jun. '34), 115 East 169th St., New York, N.Y.

Griffin, Guy Eben (Assoc. M. '35), San. Engr., Sewer Comm., Greenwich (Res., 11 Field Rd., Coscob), Conn.

Hoad, John Green (Jun. '34), Clerk, Finance Div., State Highway Dept., Lansing, Mich.

Holmes, William Worth (Jun. '34), Instrumentman, State Highway Dept., Box 23, Dumas, Tex.

Kellow, Gaylord Armand (Jun. '35), 106 Eighth Ave., East, Cresco, Iowa.

Kensley, Phillip Ray (Jun. '34), Blueprinter and Draftsman, N. P. Ry., 181 King St., Seattle, Wash.

Lake, Irving Joseph (Assoc. M. '35), 132 Eighty-seventh St., Brooklyn, N.Y.

Larson, Everett Harmon (Jun. '35), Junior Topographic Engr., U. S. Geological Survey; 91 West 2d North, Logan, Utah.

Lewin, Harold Andrew (Jun. '35), Asst. Res. Engr. Insp., Public Works Administration, 2d and College Sts., Jamestown, N.Y.

Locraft, Bernard Francis (Assoc. M. '35), Civ. Engr. with James Berrall, 615 Colorado Bldg. (Res., 45 Rhode Island Ave., N. E.), Washington, D.C.

McMullen, Onie El Roy (M. '34), Regional Structural Engr., Portland Cement Assoc., 1528 Walnut St., Philadelphia (Res., 176 North Wycombe Ave., Lansdowne), Pa.

Maynard, Fred Joseph (Jun. '34), 1315 N St., N.W., Washington, D.C.

Moore, William Wallace (Jun. '34), 3118 Sherwood Ave., Alhambra, Calif.

Mundy, Andrew Jackson, Jr. (Jun. '34), 435 Langhorn St., S.W., Atlanta, Ga.

Neil, Patric Wilson (Jun. '34), 1112 El Paso St., Plainview, Tex.

Newman, Ervin Francis (Jun. '35), Eng. Aide, Tennessee Val. Authority (Res., 107 East Broadway, Fountain City), Knoxville, Tenn.

Page, Otis Moore (M. '35), with U. S. Dept. of Agriculture, Bureau of Agri. Eng., Dillon, S.C.

Popper, William (Jun. '35), Junior Bridge Designing Engr., State of California, San Francisco–Oakland Bay Bridge, 500 Sansome St., San Francisco (Res., 1942 Forty-seventh Ave., Oakland), Calif.

Robinson, William Allan (Jun. '34), 1515 Ridge Ave., Coraopolis, Pa.

Rohlich, Gerard Addison (Jun. '34), 812 Buchman Ave., Ridgewood, N.Y.

Romano, Patrick Anthony (Jun. '34), Asst. Engr., Works Div., Temporary Emergency Relief Administration, Engrs. Div., 79th St. and Riverside Drive (Res., 303 East 153d St.), New York, N.Y.

Sebry, James Daniel (Jun. '35), Surv., Indian Irrig. Service, Farmington, N.Mex.

Smith, Neal Dreppebach (Assoc. M. '35), Asst. Engr., Met. Water Dist. of Southern California, Box A, Banning, Calif.

Soderberg, Kermit Joseph (Jun. '34), Chainman, Survey Party, General-Shea Constr. Co., Inc., Bonneville Dam, Bonneville, Ore. (Res., 101 Cervantes Boulevard, San Francisco, Calif.)

Vanasco, Albert Joachim (Jun. '34), 2414 Hughes Ave., New York, N.Y.

Walton, Jean Richmond (Jun. '35), Surv., U. S. Indian Irrig. Service, 5th Irrig. Dist., Shiprock, N.Mex.

Wyatt, Wendell Chambers (Jun. '35), Asst. Engr., Water Conservation, State of Kansas; 3511 Locust, Kansas City, Mo.

Membership Transfers

Brielmaier, Alphonse Anthony (Jun. '28; Assoc. M. '35), With U.S. Engr. Office, Zanesville (Res., 12403 Superior Ave., Cleveland), Ohio.

Cook, Howard Lee (Jun. '31; Assoc. M. '34), Hydr. Engr., Soil Erosion Service, Dept. of the Interior, Washington, D.C. (Res., 134 Fairmont Ave., Bethesda, Md.)

Johnson, Irving Laurence (Jun. '32; Assoc. M. '35), Asst. Bridge Constr. Engr., San Francisco–Oakland Bay Bridge (Res., 175 Alhambra St.), San Francisco, Calif.

TOTAL MEMBERSHIP AS OF MARCH 9, 1935

Members	5,685
Associate Members	6,096
Corporate Members	11,781
Honorary Members	18
Juniors	3,056
Affiliates	99
Fellows	3
Total	14,957

Klegerman, Morris Herman (Jun. '28; Assoc. M. '35), Asst. Engr., Alexander Potter, 50 Church St., New York, N.Y.

Levin, Louis Frank (Assoc. M. '29; M. '35), County Engr.-Mgr., Chippewa County Road Comm., Court House, Sault Ste. Marie, Mich.

Murphy, Lawrence Patrick (Jun. '31; Assoc. M. '35), Asst. Civ. Engr., U. S. Area Engr. Office, Peoria, Ill.

Rhodes, Fred Harold, Jr. (Jun. '26; Assoc. M. '34), Instr., Gen. Civ. and Structural Eng., Univ. of Washington (Res., 2828 Forty-third Ave., West), Seattle, Wash.

Shoemaker, Edwyn Leibfried (Assoc. M. '26; M. '34), Chf. Engr., Warner Co., 1616 Walnut St. (Res., 5513 Marshall St.), Philadelphia, Pa.

Sleeper, Warren Hackman (Jun. '32; Assoc. M. '35), Asst. Engr., Minneapolis-St. Paul San. Dist. (Res., 1887 Grand Ave., Apartment 5), St. Paul, Minn.

Reinstatements

Allen, James Hale, Assoc. M., reinstated Feb. 11, 1935.

Buck, John Edward, Assoc. M., reinstated Feb. 26, 1935.

Cotten, Shepard Marrast, M., reinstated Feb. 18, 1935.

Fickenscher, Elmer Walter, Assoc. M., reinstated Feb. 25, 1935.

Funderburk, Joseph Van Meter, Assoc. M., reinstated Feb. 15, 1935.

Gorman, Arthur Ellsworth, M., reinstated Feb. 18, 1935.

Gould, Stephen Grover, Assoc. M., reinstated Feb. 13, 1935.

Handb, John Hallward, Assoc. M., reinstated Feb. 25, 1935.

Hill, Willard Alvin, Assoc. M., reinstated Feb. 13, 1935.

Hummer, John William, Jun., reinstated Mar. 2, 1935.

Jarvis, Walter Monroe, Assoc. M., reinstated Feb. 20, 1935.

Kinsey, Leon Browning, M., reinstated Feb. 13, 1935.

Knowles, James Henry, M., reinstated Feb. 19, 1935.

McLure, Norman Roosevelt, M., reinstated Feb. 23, 1935.

McNamara, Charles John, M., reinstated Feb. 21, 1935.

Norling, Sven Albert, Assoc. M., reinstated Feb. 28, 1935.

Ogram, Arthur Vaughn, Jun., reinstated Mar. 6, 1935.

Plummer, Harry Custer, Assoc. M., reinstated Feb. 18, 1935.

Post, Adolph Joseph, Assoc. M., reinstated Feb. 13, 1935.

Roller, John Edwin, Assoc. M., reinstated Feb. 28, 1935.

Shafe, Robert Louis, M., reinstated Mar. 5, 1935.

Smart, Clinton Hayner, Affiliate, reinstated Feb. 18, 1935.

Somers, Newton Lloyd, Assoc. M., reinstated Feb. 18, 1935.

WARD, WILLIAM BERNARD, Assoc. M., reinstated Feb. 14, 1935.

RESIGNATIONS

DIXON, JOSEPH GRUNDY, Jun., resigned Feb. 27, 1935.

FERNANDEZ, RODOLFO MAXIMILLIANO, Jun., resigned Feb. 28, 1935.

HAUG, RAGNAR, Assoc. M., resigned Feb. 14, 1935.

KENNY, FRANCIS JOSEPH, Jun., resigned Feb. 8, 1935.

LANICCA, WIELAND BORWELL, Jr., Jun., resigned Feb. 27, 1935.

OINOUYE, CHIKAO, Assoc. M., resigned Feb. 20, 1935.

PERRY, ARTHUR IRVING, M., resigned Feb. 8, 1935.

PUTNAM, GEORGE WILLIAM, Assoc. M., resigned March 6, 1935.

SALISBURY, ALFRED JAMES, Jr., M., resigned March 1, 1935.

WIGGLESWORTH, THOMAS HUDSON, Jun., resigned Feb. 14, 1935.

DEATHS

COLEMAN, EUGENE HUNTER. Elected Jun., Oct. 1, 1913; Assoc. M., March 13, 1917; M., March 16, 1925; died Feb. 12, 1935.

FARLEY, GODFREY PEARSON. Elected M., June 6, 1900; died Feb. 4, 1935.

HANAVAN, EUGENE CORNELIUS. Elected Assoc. M., Nov. 28, 1932; died Feb. 28, 1935.

HAYES, RALPH DANIEL. Elected Jun., June 4, 1907; Assoc. M., Aug. 31, 1909; died Feb. 20, 1935.

KIELLAND, SOREN THEODOR MUNCH BULL. Elected M., Feb. 6, 1889; died Feb. 15, 1935.

MCMILLAN, JOHN GILMORE. Elected M., Oct. 5, 1909; died Feb. 14, 1935.

PORTER, DWIGHT. Elected M., Oct. 4, 1893; died Feb. 26, 1935.

THOMPSON, RALPH PENNY. Elected Assoc. M., Nov. 21, 1921; died Feb. 16, 1935.

VOETSCH, CHARLES. Elected M., Nov. 27, 1917; died Feb. 7, 1935.

WYNNE-ROBERTS, ROBERT OWEN. Elected M., June 3, 1915; died Feb. 5, 1935.

Applications for Admission or Transfer

Condensed Records to Facilitate Comment of Members to Board of Direction

April 1, 1935 NUMBER 4

The Constitution provides that the Board of Direction shall elect or reject all applicants for admission or for transfer. In order to determine justly the eligibility of each candidate, the Board must depend largely upon the membership for information.

Every member is urged, therefore, to scan carefully the list of candidates published each month in CIVIL ENGINEERING *and to furnish the Board with data which may aid in determining the eligibility of any applicant.*

It is especially urged that a definite recommendation as to the proper grading be given in each case, inasmuch as the grading must be based upon the opinions of those who know the applicant personally as well as upon the nature and extent of his professional experience. Any facts derogatory to the personal character or professional reputation of an applicant should be promptly communicated to the Board.

Communications relating to applicants are considered strictly confidential.

The Board of Direction will not consider the applications herein contained from residents of North America until the expiration of 30 days, and from non-residents of North America until the expiration of 90 days from the date of this list.

MINIMUM REQUIREMENTS FOR ADMISSION

GRADE	GENERAL REQUIREMENT	AGE	LENGTH OF ACTIVE PRACTICE	RESPONSIBLE CHARGE OF WORK
Member	Qualified to design as well as to direct important work	35 years	12 years*	5 years of important work
Associate Member	Qualified to direct work	27 years	8 years*	1 year
Junior	Qualified for sub-professional work	20 years†	4 years*	
Affiliate	Qualified by scientific acquirements or practical experience to cooperate with engineers	35 years	12 years*	5 years of important work
Fellow	Contributor to the permanent funds of the Society			

* Graduation from an engineering school of recognized reputation is equivalent to 4 years of active practice.

† Membership ceases at age of 33 unless transferred to higher grade.

The fact that applicants refer to certain members does not necessarily mean that such members endorse.

FOR ADMISSION

BAKER, VAN KARL, Memphis, Tenn. (Age 43.) Refers to R. E. Goss, M. S. Long, J. W. Pumphrey, F. E. Richardson, O. G. Thurlow, F. W. Truss, W. S. Winn.

BLUME, JOHN AUGUST, San Francisco, Cal. (Age 26.) With U. S. Coast and Geodetic Survey. Refers to H. J. Brunnier, L. B. Reynolds, F. P. Ulrich, J. B. Wells, H. A. Williams.

BOWERS, ALEXANDER FREDERICK, Richmond, Cal. (Age 27.) With Research and Development Dept., Standard Oil Co. of California. Refers to J. M. Evans, H. H. Hall, C. Moser, E. J. Nelson, S. K. Whipple.

BROOKS, AUSTIN WHITNEY, Balboa Heights, Canal Zone. (Age 47.) Asst. Constr. Engr., Madden Dam Div., The Panama Canal. Refers to M. R. Alexander, J. G. Claybourn, B. J. Fletcher, W. B. Godfrey, R. C. Jones, R. L. Klotz, L. B. Moore, E. S. Randolph, J. L. Schley.

BROWN, GEORGE RUFUS, Houston, Tex. (Age 36.) Member of firm and Vice-Pres. in charge, Brown & Root Constr. Co. Refers to R. J. Cummins, R. M. Dunham, C. R. Haile, J. M. Howe, J. C. McVea, J. M. Nagle, C. L. Tindall, M. C. Welborn, A. J. Wise.

BRUMFIELD, RAY CARLTON, Freeport, N.Y. (Age 44.) Asst. Prof., Civ. Eng. Dept., Cooper Union. Refers to W. E. Brown, H. R. Codwise, F. E. Foss, G. R. Heckle, C. D. Pollock, M. H. Van Buren, J. P. J. Williams.

COCHRANE, HENRY PARK, Seattle, Wash. (Age 37.) With Eng. Dept., Puget Sound Navy Yard, Bremerton, Wash. Refers to I. L. Collier, G. E. Hawthorn, R. G. Hennes, C. C. More, F. H. Rhodes, Jr., R. G. Tyler.

CORTRIGHT, HARRY MILLER, Asheville, N.C. (Age 26.) Jun. Hydr. Engr., U. S. Govt., TVA. Refers to J. S. Bowman, F. M. Dawson, H. F. Janda, B. E. Morriss, F. E. Turneaure.

CROWTHER, JAMES IRVING, Baltimore, Md. (Age 25.) Refers to L. V. Carpenter, R. P. Davis.

DAVIES, WALTER GARFIELD, Devils Lake, N.Dak. (Age 53.) Engr. Examiner, Federal Emergency Administration of Public Works. Refers to J. P. Bendt, A. C. D. Blanchard, W. E. Corbett, D. A. Decker, D. B. Fegles, H. O. Garman, W. K. Hatt, C. McDonough, H. E. Stevens.

EVANS, WESTON SUMNER, Orono, Me. (Age 38.) Prof. of Civ. Eng., Univ. of Maine. Refers to P. L. Bean, H. S. Boardman, W. J. Emmons, R. L. Morrison, E. H. Sprague, J. S. Worley.

FREEMAN, OLEN IVO, Atlanta, Ga. (Age 42.) Project Mgr., Housing Div., PWA, U. S. Govt. Refers to B. M. Hall, Jr., W. A. Hansell, J. H. Johnston, R. G. Lose, F. H. McDonald, M. T. Singleton, R. W. Torras.

FRIEDEWALD, FREDERICK ROLAND, Belleville, Ill. (Age 32.) Asst. Supt. of Highways, St. Clair County Highway Dept. Refers to G. H. Baker, S. C. Baker, W. M. Brown, A. A. A. Coleman, B. C. McCurdy, A. P. Poirot, C. M. Slaymaker.

FRIEL, GILBERT MOIR, San Francisco, Cal. (Age 24.) Yard Asst., McClintic-Marshall Co. Refers to B. A. Etcheverry, C. G. Hyde.

GEDO, JULES DUCI, New York City. (Age 42.) Structural Designer, A. D. Crosett, Cons. Engr. Refers to E. W. Benes, A. D. Crosett, S. Frieman, H. G. Hauck, J. Tarnay.

GINORIO, ULISES CADILLA, Arecibo, Puerto Rico. (Age 29.) Senior Inspector, U. S. Engr. Office, War Dept., San Juan, Puerto Rico. Refers to R. R. Casellas, J. V. Davila, B. W. Pegues, R. Ramirez, A. S. Romero, E. Totti y Torres.

GOFSEVEFF, SAMUEL, Brooklyn, N.Y. (Age 26.) Refers to R. E. Goodwin, F. O. X. McLoughlin, J. S. Peck, J. C. Rathbun.

GRADY, HAMILTON GAMBLE, Los Angeles, Cal. (Age 41.) Design Engr., Consolidated Steel Corporation, Inc. Refers to A. H. Ayers, O. Dunkel, R. P. Miller, A. G. Roach, N. Werner.

GREEN, DANIEL PARKER, Cookeville, Tenn. (Age 37.) 1st Lieut., U. S. Army Engr. Reserve; Dist. Engr., 6th Eng. Dist., Tennessee CWA and TERA. Refers to R. H. Baker, C. W. Butts, H. Kramer, R. S. Lillard, C. H. Schwartz, M. U. Snoderly.

GREVEMBERG, FRANCIS BARTHOLOMEW, New Orleans, La. (Age 48.) Parish ERA Engr. Refers to E. S. Bres, J. P. Coleman, A. T. Dusenbury, J. T. Eastwood, A. M. Fromherz, H. M. Gallagher, C. M. Kerr, J. Klorer, A. J. Negrotto, J. H. O'Neill, A. P. Theard.

HARKNESS, FRANK BRACE, Zanesville, Ohio. (Age 31.) Engr., U. S. Dist. Engr. Office. Refers to W. T. Howe, T. T. Knappen, A. L. Pauls, R. W. Powell, E. E. Teeter, C. Voetsch, B. R. Wood.

HEILBRON, CARL HENRY, JR., Pasadena, Cal. (Age 30.) Asst. Engr. (Design), Metropolitan Water Dist. of Southern California. Refers to W. C. Christopher, D. B. Gumensky, J. Hinds, S. B. Morris, C. E. Pearce, V. L. Peugh, C. W. Sopp.

HOLZER, FRANK, Quincy, Mass. (Age 39.) Field Engr., Fay, Spofford & Thorndike, Boston, Mass. Refers to J. Ayer, C. A. Farwell, F. H. Fay, R. W. Horne, W. W. Parks, C. M. Spofford, H. J. Williams.

INMAN, CHARLES HORACE, JR., Flushing, N.Y. (Age 22.) Refers to F. E. Foss, R. F. Wheadon.

KALER, STEPHEN SCAMMAN, Washington, D.C. (Age 33.) Tech. Clerk, Inspection Div., PWA. Refers to H. L. Doten, F. O. Dufour, J. W. Fenton, G. A. Graham, A. C. Klingenberg, V. B. Siems, R. Warren.

KOCHIS, FRANK, Portland, Ore. (Age 27.) Associate Engr., U. S. Engineers. Refers to J. J. Doland, H. G. Gerdes, C. I. Grimm, D. C. Henny, J. P. Hogan, H. A. Rands.

KOO, TSU-YUAN, Chapel Hill, N.C. (Age 30.) Graduate Student, Univ. of North Carolina. Refers to H. G. Baity, S. Eliassen, T. F. Hickerson, O. J. Todd, P.-L. Yang.

LAMURA, ANTHONY RUDOLPH, New York City. (Age 31.) Pres., A. R. LaMura, Inc. Refers to H. B. Brewster, T. M. Burns, E. Diebitsch, F. A. O'Hare, G. D. Williams.

MACBRIDE, EARL ALEXANDER, Seymour, Ind. (Age 21.) Inspector, Indiana State Highway Comm. Refers to J. T. Hallett, G. R. Harr, M. R. Keefe, F. Kellam, W. A. Knapp, R. B. Wiley.

MIESENHELDER, PAUL DAVID, Indianapolis, Ind. (Age 39.) Refers to S. W. Benham, H. O. Garman, J. T. Hallett, F. Kellam, W. A. Knapp, D. B. Rush, W. J. Titus.

NANRY, JOHN JAMES, Pearl River, N.Y. (Age 49.) Engr.-Examiner with State Engr., Federal PWA, New York City. Refers to F. S. Crowell, G. H. Nolan, R. Ridgway, J. F. Sanborn, J. B. Snow, C. E. Trout, A. S. Tuttle.

ODOM, LEO MYERS, New Orleans, La. (Age 29.) Res. Engr., Corps of Engrs., U. S. Army, First New Orleans Dist. Refers to J. P. Ewin, N. E. Lant, B. W. Pegues, J. Riess, W. B. Smith, H. L. Williams, C. A. D. Young.

OGDEN, WILLIAM HALL, Glen Cove, N.Y. (Age 29.) Mgr., Glen Cove Plant, New York Water Service Corporation. Refers to B. A. Bennett, F. W. Collins, A. W. Cuddeback, E. Devendorf, G. D. Norcom, H. N. Ogden, T. H. Wiggin.

PACHON-ROJAS, LUIS, Boston, Mass. (Age 29.) Refers to J. B. Babcock, 3d, C. B. Breed, J. W. Howard.

QUIMBY, PAUL JAY, Bethlehem, Pa. (Age 37.) Engr., McClintic-Marshall Corporation. Refers to E. F. Ball, E. L. Durkee, C. Elcock, J. Jones, T. R. Lawson.

REED, CHARLES EMORY, Santa Fe, N.Mex. (Age 32.) With New Mexico Highway Comm. Refers to J. P. Bacca, E. L. Barrows, J. H. Bliss, B. Johnson, W. E. Jones, Jr., G. D. Macy, W. E. Strohm.

RICHARDI, EUPLIO, East Walpole, Mass. (Age 21.) Refers to N. D. Morgan, C. E. Palmer.

RIGHTER, GORDON TURNER, Pelham Manor, N.Y. (Age 29.) Eng. Asst. with Pres., Borough of Bronx, Bureau of Design, New York City. Refers to E. F. Fox, M. W. Hall, C. M. Mapes, A. V. Sheridan, R. J. Smyth.

ROGERS, JOHN WILLARD, Monrovia, Cal. (Age 26.) With West Slope Constr. Co. Refers to F. L. Copeland, D. A. Daly, R. Rasmussen, L. C. Rogers, W. A. Rogers, L. W. Russell, J. F. Stevens.

RORHUS, NILS, Harrisburg, Pa. (Age 37.) Structural Engr., Snow-Weaver Industrial Management, Inc. Refers to I. M. Lyse, O. J. Marsten, C. H. Mercer, F. H. Snow, A. J. Willis.

RUTLEDGE, DWIGHT HANEY, Sacramento, Cal. (Age 30.) Asst. Engr., Topographic Branch, U. S. Geological Survey. Refers to L. L. Bryan, R. T. Evans, H. H. Hodgeson, R. R. Monbeck, C. N. Mortenson, J. G. Staack.

RUTT, FRANK EDWARD, Iowa City, Iowa. (Age 26.) Jun. Engr., U. S. Engrs., St. Paul Dist. Hydraulic Laboratory. Refers to H. M. Hill, R. L. Stevens.

SANDUSKY, JOHN WILLIAM, Seattle, Wash. (Age 25.) Refers to I. L. Collier, G. E. Hawthorn, C. C. More, R. G. Tyler.

SAYLOR, WILLIAM HENRY, Los Angeles, Cal. (Age 26.) Experimental work for Metropolitan Water Dist. of Southern California. Refers to W. C. Christopher, R. E. Davis, R. B. Diemer, D. B. Gumensky, S. T. Harding, J. Hinds, F. Thomas.

SHACK, STEPHEN GEORGE, Pittsburgh, Pa. (Age 25.) Refers to F. J. Evans, F. M. McCullough, E. G. Messner, C. E. Portas.

SMITH, HOWARD WRIGHT, Kansas City, Mo. (Age 51.) Engr., Way & Structures, Kansas City Public Service Co. Refers to J. V. Hanna, E. E. Howard, J. V. McKinney, E. M. Stayton, M. S. Murray.

SPEER, PAUL RUDOLPH, Harrisburg, Pa. (Age 30.) Asst. Engr., U. S. Geological Survey, Water Resources Branch. Refers to E. D. Burchard, N. C. Grover, A. H. Horton, J. C. Hoyt, J. W. Mangan, R. O'Donnell, C. G. Paulsen, E. D. Walker, D. S. Wallace.

STOCK, ELDON MARK, Logan, Utah. (Age 26.) Engr., Project 3-B 9-92, FERA. Refers to G. D. Clyde, O. W. Israelsen, H. R. Kepner, R. B. West.

STREET, GUSTAVUS CALDER, JR., Ft. Worth, Tex. (Age 50.) State Engr. Inspector, PWA. Refers to R. J. Cummins, H. E. Elrod, P. M. Geren, F. E. Giesecke, J. Montgomery, E. N. Noyes, J. E. Pirie, J. Rady, R. A. Thompson, P. A. Welty.

SWIECH, PAUL CHARLES, Carnegie, Pa. (Age 27.) Transitman on sewer surveys for City of Pittsburgh, financed by L. W. D. (R. W. D.). Refers to F. J. Evans, F. M. McCullough.

THOMAS, CHARLES EDWARD, Seattle, Wash. (Age 51.) Engr.-Inspector, FEA of PW, in charge of PWA projects in King County, Wash. Refers to C. J. Bartholet, R. M. Copeland, L. E. Gregory, T. D. Hunt, L. V. Murrow, R. K. Tiffany.

THOMPSON, ROBERT BARKER, Cambridge, Mass. (Age 24.) Graduate student, Asst. to Prof., and Research Asst., in Civ. and San. Eng., Massachusetts Inst. of Technology. Refers to J. B. Babcock, 3d, C. B. Breed, T. R. Camp, G. E. Russell, C. M. Spofford.

VAN DUYNE, RICHARD, Long Island City, N.Y. (Age 35.) Asst. Engr., TERA, Works Div., New York City. Refers to C. M. Leahy, E. W. Ritchie, R. C. Springer, A. Van Siller, D. M. Zwanziger.

VOCKROTH, JOHN HENRY, Dunmore, Pa. (Age 25.) Mastriani, Riggi & Vockroth, Archts. and Engrs., Scranton, Pa. Refers to S. Baker, C. M. Roberts, T. R. Williams.

VOGELGESANG, CARL EDGAR, Indianapolis, Ind. (Age 37.) Engr. of Plans, Indiana State Highway Comm. Refers to W. R. Britton, J. T. Hallett, G. R. Harr, M. R. Keefe, F. Kellam, G. E. Lommel, C. W. McClain, L. V. Sheridan, W. J. Titus, J. W. Wheeler.

WARNER, ROY FERDINAND, Iowa City, Iowa. (Age 28.) Surveyman, Corps of Engrs., U. S. Army, St. Paul, Minn., Dist. Office. Refers to A. S. Cutler, A. Daniels.

WELLS, JOHN FOREMAN, Elmhurst, N.Y. (Elected Junior June 4, 1928.) (Age 33.) Computer, The Geophysical Co., Inc., Woodhaven, N.Y. Refers to E. F. Ball, W. H. Chorlton, D. S. Gendell, Jr., M. G. Littlefield, H. D. Robinson, D. B. Steinman, F. P. Witmer.

WISHART, WILLIAM THOMAS, Phoenix, Ariz. (Age 28.) Designer, Bridge Dept., Arizona Highway Dept. Refers to R. A. Hoffman, E. V. Miller, J. S. Mills, J. W. Powers, S. Smyth.

FOR TRANSFER

FROM THE GRADE OF ASSOCIATE MEMBER

BECKER, WILLIAM CHRIS EMIL, Assoc. M., St. Louis, Mo. (Elected Jan. 17, 1921.) (Age 44.) Engr. of Bridges and Bldgs., City of St. Louis. Refers to H. Austill, B. L. Brown, W. J. Burton, E. B. Fay, E. Flad, J. T. Garrett, W. W. Horner, F. G. Jonah, J. H. Porter, C. D. Purdon, E. O. Sweetser, J. C. Travilla, J. L. Van Ornum, E. E. Wall, S. L. Wonson.

CARGILL, DANIEL OLNEY, Assoc. M., Valley Falls R.I. (Elected Oct. 26, 1931.) (Age 36.) Bridge Engr., State Board of Public Roads; also Tech. Advisor, Washington Bridge Comm., Providence, R.I., Refers to C. H. Dutton, A. G. Hayden, G. H. Henderson, C. W. Hudson, H. E. Miller, D. B. Steinman, F. C. Williams.

GARDNER, GEORGE WASHINGTON, Assoc. M., Lowville, N.Y. (Elected Junior Jan. 15, 1917; Assoc. M. April 19, 1920.) (Age 46.) Cons. Engr. in private practice, also Village Engr. of Lowville. Refers to E. H. Feldmann, N. P. Henderson, F. J. Laverty, C. J. Sheridan, C. J. Suhr, J. W. Van Denburg, F. C. Zeigler.

GOODWIN, RALPH EDWARD, Assoc. M., New York City. (Elected Junior Oct. 1, 1912; Assoc. M. April 16, 1918.) (Age 48.) Asst. Prof. of Civ. Eng., School of Technology, Coll. of City of New York. Refers to C. T. Bishop, C. S. Farnham, F. H. Frankland, G. L. Lucas, F. O. X. McLoughlin, J. C. Rathbun, A. P. Richmond, Jr., R. Ridgway, J. C. Tracy.

HARRIS, HARRY FALLON, Assoc. M., Trenton, N.J. (Elected Feb. 4, 1914.) (Age 52.) County Engr., Mercer County, N.J. Refers to J. L. Bauer, W. C. Cattell, M. Goodkind, A. C. Gregory, A. H. Nelson, F. J. Radigan, A. Swan, Jr.

HICKLIN, ROBERT GUTHRIE, Assoc. M., Atlanta, Ga. (Elected Oct. 10, 1927.) (Age 37.) Managing Engr., Municipal Dept., Robert & Co., Inc. Refers to P. M. Feltham, J. L. Goldman, B. M. Hall, Jr., W. E. Reynolds, L. W. Robert, Jr., S. R. Young.

JENKINS, CARTER, Assoc. M., Des Plaines, Ill. (Elected June 6, 1927.) (Age 41.) Sr. Eng. Inspector, National Park Service, Dept. of Interior. Refers to W. H. Allen, O. G. Baxter, J. B. Black, A. W. Consoer, C. E. De Leuw, F. T. Sheets.

KAMPF, MORRIS, Assoc. M., New York City. (Elected Aug. 27, 1928.) (Age 39.) Cons. Engr. Refers to C. W. Hudson, H. C. Keith, G. Pinner, D. J. Shaw, G. A. Sherron.

MEADOWCROFT, WILLIAM, Assoc. M., New York City. (Elected Dec. 6, 1905.) (Age 56.) Eng. Consultant, Inst. of Public Administration. Refers to C. L. Bogert, H. R. Bouton, A. D. Flinn, J. P. Hogan, A. H. Pratt, J. F. Sanborn, F. E. Winsor.

MIEDWIG, ANDREW, Assoc. M., Brookline, Pa. (Elected July 6, 1920.) (Age 46.) Superv. Engr., Day & Zimmermann Eng. & Constr. Co., Philadelphia, Pa. Refers to C. D. Babcock, T. F. Gibson, F. N. Kneas, J. W. May, G. F. Rowell.

PHANEUF, VICTOR SIMEON, Assoc. M., Nashua, N.H. (Elected March 5, 1928.) (Age 36.) Commanding Officer, Engr. Reserves, U. S. Army, on maintenance and administration of a CCC camp, Lyndonville, Vt. Refers to J. W. Childs, F. E. Everett, G. G. Shedd, L. W. West, G. P. Winn.

RINEHART, GERALD STAATS, Assoc. M., New York City. (Elected Sept. 12, 1921.) (Age 46.) With PWA. Refers to G. H. Bayles, C. E. Beam, J. H. Caton, 3d, H. W. Durham, M. E. Gilmore, R. W. Hebard, G. L. Robinson.

WARD, WILLIAM BERNARD, Assoc. M., Cincinnati, Ohio. (Elected Dec. 15, 1924.) (Age 44.) Member of firm, Tietig & Lee, Archts. Refers to W. W. Carlton, H. J. Gould, H. W. Hanly, H. D. Loring, F. W. Morrill, W. V. Schmiedeke.

FROM THE GRADE OF JUNIOR

BAILLY, FLORENT HOULDING, Jun., Caracas, Venezuela. (Elected Dec. 5, 1927.) (Age 32.) Chf. Engr., Venezuelan Pantepec Co. Refers to B. Aguerrevere, J. M. Ibarra Cerezo, C. W. O'Connell, J. K. Stubbins, F. Thomas.

BROSELL, EDWARD SOLFRID, Jun., Brooklyn, N.Y. (Elected Feb. 24, 1931.) (Age 28.) Designer, Ambursen Eng. Co., New York City. Refers to E. H. Burroughs, Jr., C. V. Davis, D. A. Dedel, F. Hudson, Jr., A. H. Jorgensen, A. F. Lipari, S. W. Stewart.

CANALS, CESAR SOCORRO, Jun., Grafton, W.Va. (Elected June 6, 1927.) (Age 32.) Engr., Frederick Snare Corporation, New York City. Refers to R. H. Cady, A. Deermont, M. Font, H. H. Haggard, A. S. Lucchetti-Otero, G. P. Seeley, Jr., C. M. Spofford.

CARTER, ROBERT LAYTON, Jun., Olympia, Wash. (Elected Nov. 12, 1928.) (Age 30.) Structural Designer, Oregon-Washington Bridge Co. Refers to E. M. Chandler, E. C. Dohm, E. L. Greene, R. M. Murray, G. S. Richardson, B. P. Thomas.

CHOW, LEE, Jun., Tsinan, China. (Elected Nov. 12, 1928.) (Age 32.) Senior Engr., Hydr. Dept., Shantung Re-construction Bureau; Engr. in Chf., Shiao Tsing River Improvement Comm. Refers to H. Cross, S. Eliassen, W. C. Huntington, S-T. Li, P-L. Yang.

EVANS, LEONARD THOMAS, Jun., Long Beach, Cal. (Elected April 12, 1926.) (Age 32.) Cons. Structural Engr. (registered). Refers to A. J. Boase, F. A. Busse, E. L. Eriksen, P. Moller, R. W. Stewart, J. Sweeney, H. C. Whittlesey.

GITTLESON, IRVIN, Jun., New York City. (Elected Dec. 26, 1933.) (Age 32.) Draftsman, Ash-Howard-Needles & Tammen. Refers to T. E. Brown, Jr., F. De Schauensee, A. T. Granger, S. Hardesty, E. L. Macdonald, H. C. Tammen, J. A. L. Waddell, W. G. Williams.

HANSEN, JAMES HAROLD, Jun., New York City. (Elected July 14, 1930.) (Age 32.) Secy.-Mgr., Brick Mfrs. Association of New York. Refers to O. P. L. Albert, H. T. Larsen, D. E. Parsons, C. T. Schwarze, S. Wilmot.

KEELY, CHARLES CLARKE, Jun., Long Beach, Cal. (Elected Oct. 1, 1926.) (Age 32.) Asst. Commercial Operations Engr., Associated Telephone Utilities System. Refers to A. R. Ariedge, A. R. Baker, R. W. Carlson, W. L. Chadwick, C. C. Elder, R. H. Suttie, R. B. Ward.

KNIESTEDT, EWALD MATTHEW, Jun., St. Louis, Mo. (Elected Nov. 15, 1926.) (Age 32.) Engr. in charge Engr. Sec., U. S. Engr. Office. Refers to E. C. Constance, A. B. Greene, A. F. Griffin, W. H. McAlpine, J. W. Skelly.

KNOX, JOHN JAMES, Jun., Elmhurst, N.Y. (Elected Oct. 14, 1929.) (Age 28.) Asst. Engr., Interborough Rapid Transit Co., New York City. Refers to O. G. H. Buettner, J. K. Finch, F. W. Gardiner, H. Grant, W. G. Grove, W. J. Krefeld, W. C. Merryman, G. H. Pegram, W. F. Reeves.

MASTRIANI, SAMUEL GABRIEL, Jun., Dunmore, Pa. (Elected Nov. 15, 1926.) (Age 31.) Borough Engr., Boroughs of Dunmore and Throop, Pa. Refers to S. Baker, G. G. Jacobosky, T. H. Moyer, C. M. Roberts, T. R. Williams.

MORE, CHARLES, Jun., Bridgeport, Conn. (Elected Dec. 15, 1924.) (Age 32.) Draftsman, U. S. Coast & Geodetic Survey. Refers to T. Barbato, J. Feld, H. T. Immerman, J. F. Jung, F. W. Kosting, G. C. Mattison.

O'SHEA, DANIEL GEORGE, Jun., Denver, Colo., (Elected July 12, 1926.) (Age 32.) Asst. Engr. U. S. Bureau of Reclamation. Refers to A. L. Alin, E. B. Debler, J. Jacobs, C. C. More, H. A. Rands, A. J. Turner, C. A. D. Young.

SCHULEEN, ERNEST THEODORE, Jun., Holtwood, Pa. (Elected Dec. 5, 1927.) (Age 32.) Asst. to Engr., Hydr. Test Dept., Pennsylvania Water & Power Co. Refers to L. M. Davis, R. F. Ewald, J. P. Growdon, S. L. Kerr, J. W. Rickey, J. E. Stewart, D. L. Yarnell.

SPAFFORD, HILDRETH ANCEL, Jun., Springfield, Ill. (Elected Oct. 10, 1927.) (Age 32.) Asst. San. Engr., Illinois Dept. of Public Health; Consultant to Illinois State Archt.'s Office. Refers to J. L. Clarke, J. J. Hinman, Jr., E. R. Knight, F. G. Merckel, H. E. Miller, R. V. Tilly, A. H. Wieters.

VAN VALKENBURGH, HAROLD TRUMB, Jun., Dallas, Tex. (Elected July 12, 1926.) (Age 32.) Engr., Texas Power & Light Co. Refers to B. R. Brown, G. W. Gill, O. H. Koch, A. T. Larned, A. L. Pauls, A. P. Rollins.

WESSENAUER, GABRIEL OTTO, Jun., Pittsburgh, Pa. (Elected Oct. 10, 1927.) (Age 28.) Development Engr. and Asst. Electrical Engr., West Penn Elec. Co. Refers to P. F. Kruse, F. M. McCullough, C. B. Stanton, J. E. Stewart, H. A. Thomas, E. B. Whitman.

YATES, JOHN PERRY, Jun., Earp, Cal. (Elected Oct. 1, 1926.) (Age 31.) Res. Engr., Six Companies, Inc., Gen. Contrs. Refers to A. H. Ayers, N. A. Bowers, C. Bradshaw, F. T. Crowe, C. Derleth, Jr., R. Matthew, F. C. Scobey, F. H. Tibbetts.

The Board of Direction will consider the applications in this list not less than thirty days after the date of issue.

Men Available

These items are from information furnished by the Engineering Societies Employment Service, with offices in Chicago, New York, and San Francisco. The service is available to all members of the contributing societies. A complete statement of the procedure, the location of offices, and the fee is to be found on page 85 of the 1934 Year Book of the Society. To expedite publication, notices should be sent direct to the Employment Service, 31 West 39th Street, New York, N.Y. Employers should address replies to the key number, care of the New York Office, unless the word Chicago or San Francisco follows the key number, when it should be sent to the office designated.

CONSTRUCTION

CONSTRUCTION ENGINEER; Jun. Am. Soc. C.E.; 25; licensed land surveyor; now engineer inspector of water-works construction; 3 years experience, construction of bridges, grade-crossing eliminations, retaining walls, station facilities, sewers, pavements, etc. Land and topography surveys. Desires permanent connection with consulting engineer, contractor, or corporation. Available July 1. D-2876.

GRADUATE CIVIL ENGINEER; Assoc. M. Am. Soc. C.E.; 34; experienced field and office engineer familiar with surveying, inspecting, drafting, estimating, and supervising construction; 9 years in responsible position during construction of large water supply and power development. Desires position offering permanent possibilities. Location immaterial. D-3755.

DESIGN

CIVIL ENGINEER; Jun. Am. Soc. C.E.; age 28; B.S. in C.E.; 6 years of broad experience in the designing and construction of sewage disposal plants, concrete buildings, water works, gas distribution systems, highways, and concrete bridges; accurate draftsman. Desires connection with industrial or utility corporation or consulting engineer. D-2559.

CIVIL ENGINEER; Assoc. M. Am. Soc. C.E.; 23 years experience; 2 degrees; design, surveying, estimating for contractor. Factories, railroads, housing, real estate development. A-2505.

EXECUTIVE

CIVIL ENGINEER; M. Am. Soc. C.E.; 45; married; C.E., Cornell University, 1913. Over 20 years varied engineering experience, including municipal work, building construction, estimating, specifications, town planning. Desires an executive position in any branch of civil engineering. Location western United States. Available at once. C-611-352-A-7-San Francisco.

GRADUATE CIVIL AND STRUCTURAL ENGINEER; Assoc. M. Am. Soc. C.E.; 15 years experience. Highway survey and construction, topographic and hydrographic surveys for hydraulic dredging, river and harbor improvement, canals, docks, port works, heavy hydraulic fills, boring; 8 years structural design of schools, hospitals, warehouses, garages, office buildings. Will go anywhere, but New England preferred. D-3713.

CIVIL ENGINEER; Assoc. M. Am. Soc. C.E.; 38; B.S. and C.E. degrees, University of Colorado; 16 years experience—railroad and highway construction and design, reinforced concrete and timber design, structural analysis, hydraulic studies, estimating, report writing, economic studies; now employed. Desires responsible structural or teaching position with opportunity for promotion, in western United States. D-3742.

SANITARY ENGINEER; M. Am. Soc. C.E.; 61; B.S., Princeton University, 1894; 20 years experience, planning collection, treatment, and disposal of sewage; 7 years on water purification. Also, valuation of gas and water utilities, design of sand and gravel plants. Hydraulics of canals, rivers, and conduits. During War, in charge of engineer schools, U. S. Army. D-3727.

CIVIL AND MECHANICAL ENGINEER; M. Am. Soc. C.E.; former member A.S.M.E.; 49; single; 22 years in responsible charge of river and harbor improvements, including operation and maintenance of large dredging fleet, port planning, design and construction of breakwaters, piers, wharves, transit sheds, etc. Available on short notice. D-3758.

CONTRACTOR'S ENGINEER; M. Am. Soc. C.E.; 24 years general contracting, supervision, design, special studies on heavy construction. Expert on construction methods, plant, costs, preparation of bids, purchasing, subcontracts, organization in field and office; C.E. degree; New York State licenses. Available immediately; salary and location open. Interviews solicited. B-548.

CONCRETE SPECIALIST; Assoc. M. Am. Soc. C.E.; 32; 10 years experience; capable of organizing and supervising concrete inspection, and concrete testing laboratory on large projects. Experience on special investigation and reports on concrete and the behavior of its constituents. Several papers and discussions published in technical periodicals. Excellent references. C-8022.

ENGINEER EXECUTIVE; M. Am. Soc. C.E.; registered professional engineer, Pennsylvania. For over 20 years connected with structural steel fabrication business as well as general contracting. General management and supervision of engineering, sales, and plant operations. Available immediately. C-5095.

JUNIOR

CIVIL ENGINEER; Jun. Am. Soc. C.E.; 23; single. Highway earthwork, surveying, and drafting. Learns easily; will work anywhere. Desires engineering position giving maximum experience and hard work. Wants good pay and is willing to earn it. D-3720-352-A-6-San Francisco.

CIVIL ENGINEER; Jun. Am. Soc. C.E.; age 21; C.E. degree, Rensselaer Polytechnic Institute, 1934. Desires opportunity in any branch of civil engineering. Experience is main objective; salary is secondary. Available immediately. Location immaterial—United States or foreign countries. D-3724.